Supplement to *HortScience*

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This supplement contains the abstracts of presentations from the National Conference of the American Society for Horticultural Science

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Abstracts of Presentations

from the

Annual Conference

of the

American Society for Horticultural Science
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Supplement to *HortScience*

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Part 1: Special Sessions and Workshops

SPECIAL SESSIONS AND WORKSHOPS

Monday, July 22, 2019

History of Controlled Environment Horticulture *CEU Approved*

Coordinator: Jules Janick
Purdue University, West Lafayette, IN, United States
Moderator: Jules Janick
Purdue University, West Lafayette, IN, United States

Description:
This session will review controlled environment horticulture from antiquity to the present.

8:00 AM – 8:15 AM

The Ancient Origins of Controlled Environment Horticulture

Jules Janick*, Purdue University

In the first century CE, two Roman agricultural writers, Lucius Junius Moderatus Columella and Gaius Plinius Secundus (Pliny the Elder), referred to proto-greenhouses (specularia) constructed for the Emperor Tiberius (42 BCE–37 CE) presumably adjacent to his palace, the Villa Jovis on the Isle of Capri. Pliny stated in *Historia Naturalis* (Book 19,23:64) that the *specularia* consisted of beds mounted on wheels which were moved into the sun and on wintry days withdrew under the cover of frames glazed with transparent stone (*lapis specularis* or mica). Apparently the specularia were built to provide fruits of *cucumis*, "*a delicacy for which the Emperor Tiberiuis , had a remarkable partiality; in fact there was never a day on which he was not supplied it*. The *cucumis* described by Columella and Pliny, long mistranslated as cucumber, were in fact long-fruited forms of *Cucumis melo* subsp. *melo*, Flexuosis Group. They are known today as vegetable melons, snake melons, and faqqous and were highly esteemed in Rome and ancient Israel.

8:15 AM – 8:35 AM

Renaissance Orangeries and Victorian Conservatories

Christopher J. Currey*, Iowa State University

Renaissance orangeries and Victorian conservatories were originally developed to serve as ornate, decorative structures designed to improve plant growth under unfavorable temperatures and low light. Several factors contributed to the development of these structures. First, global exploration increased the importation of exotic plant materials which, commonly originating from sub-tropical and tropical climates. As the names imply, orangeries and limonaias were constructed to protect tender fruits, as well as ornamental plants, requiring protection in temperate European climates during winter upon being brought back. In addition the influx of exotic plant materials requiring modified environments to survive and flourish, technological advancements in glass manufacturing allowed for glass panes of substantial size to be produced. These panes used in structures provided substantially more light to tender, protected plants throughout the winter. While these structures were built to protect plants, they were also made possible by and represented the wealth and opulence of their owners and patrons. Their wealth was not only reflected in the exotic plant collections and the structures that housed them, but also in the design and feature of their interior spaces. The fundamental design of these structures resemble modern-day lean-to or deep-winter greenhouse structures; transparent glazing material were placed on the south-facing walls of structures, while north walls were constructed of opaque materials with much greater insulation values. The development of Renaissance orangeries and Victorian conservatories served as important progenitors to our modern-day greenhouses.

8:35 AM – 9:00 AM

High Tunnels

Ajay Nair*, Iowa State University

High Tunnels are an expansion of plastic cover technology that date to use of portable, bell shaped glass covers (cloche) over individual plant in the 19th century. History of high tunnels dates back to 1955 when Dr. Emery Emmert, a horticulture professor at University of Kentucky, first used plastic covers in greenhouse. In the United States, 50 years after their creation, growers are beginning to take advantage of the opportunities that high tunnels provide. High tunnels have become an important production tool for vegetable, small fruit, and cut flower growers in many parts of the United States, especially the Midwest, southeast and northern states. The recently concluded agriculture census reports that sales from crops grown in protected culture systems in the U.S. totaled nearly $748 million, which includes high tunnels and greenhouses. High tunnels provide a protected environment relative to the open field, allowing for season extension, lower incidence of diseases, and improved yield and quality. Producers, ranging from small-scale diversified to larger scale farms, are utilizing high tunnels to: 1) locally produce crops for early markets, 2) grow diversified crops such as tomato, lettuce, peppers, cut flowers, strawberries, and brambles, 3) improve yield and produce quality, and 4) increase farm profitability. Many land-grant universities, non-profit organizations, and cities have stepped up efforts

An asterisk (*) in front of a name indicates the presenting author.

to address grower and community needs and food security issues using high tunnels. The NRCS Environmental Quality Incentive Program has played a key role in the expansion and adoption of high tunnels through its high tunnel cost-share program. More than 10,000 U.S. farms are reported to have installed at least one HT from 2009-2014 with EQIP support. Overall, USDA reports that it has processed nearly seventeen thousand requests for HT financing through EQIP since 2010, with the total number of EQIP-financed HTs increasing eleven-fold, on average, in each state from 2010-2018. As high tunnel acreage expands, we can look forward to new and innovative crop production techniques and significant growth in industries that manufacture tools, equipment, sensors, and environmental monitoring systems for high tunnel crop production.

9:00 AM – 9:30 AM

Modern Climate-Controlled Greenhouses

Krishna Nemali*, Purdue University

Crops valued at billions of dollars are produced annually in climate-controlled greenhouses. Modern day greenhouses are designed to withstand extreme climates, include state-of-the art technology for environmental monitoring and control, and enable year-round production. Ornamentals, food crops, and medicinal plants are produced under high planting densities and using intense cultivation practices in modern greenhouses. Soilless and hydroponic production systems along with supplemental lighting, heating, CO_2 enrichment are used to grow crops. Commercial greenhouses can span several acres under the roof, with largest concentration of 35,000 ha in one region of Spain. This presentation will describe the history behind some of the giant technological leaps in greenhouse industry from its inception during 17th century in Europe to present, with emphasis on environmental control.

9:30 AM – 10:00 AM

Indoor Horticulture and Vertical Farms

Cary A. Mitchell*, Purdue University

A new sector of protected horticulture involves a combination of sole-source electric lighting and soilless cultivation within insulated, environmentally controlled warehouses. For low-profile microgreens, baby greens, leafy greens, and culinary herbs, it is possible to mount hydroponic culture trays and overhead lighting fixtures on racks in multiple vertical tiers within high-bay buildings. Such indoor-agriculture (IA) / vertical-farm (VF) operations can produce greens crops year-round locally in otherwise seasonal climates with crop-yield potential two orders of magnitude higher than for field production on an annualized, land-area-footprint basis. When effective pest-exclusion and stringent sanitation measures are practiced, produce can be grown pesticide-free. Emission spectra from light-emitting diodes (LEDs) can be selected or manipulated to not only promote crop yield, but also crop-quality parameters such as texture, flavor, pigmentation, and phytonutrient content. Under such high environmental control, lighting and growth prescriptions can be developed for individual species and cultivars. Vertical farming requires up-front investment in costly technology as well as expensive costs of operation, especially electricity for lighting as well as associated heating-ventilating-air-conditioning (HVAC) needs. Thus, the availability, freshness, and quality of year-round VF produce must command premium pricing in the local marketplace. Issues of consumer willingness to pay, business profitability, carbon footprint, seasonal competition from field-grown produce, local regulations, investor return on investment, and consumer acceptance of indoor growth technology are just some of the issues that the nascent VF industry is dealing with in struggling to become viable. Research addressing all of these factors is badly needed!

Growing Global Citizens; Internationalizing Horticultural Curriculum *CEU Approved*

Coordinator: Curt Rom
University of Arkansas, Fayetteville, AR, USA
Moderator: Curt Rom
University of Arkansas, Fayetteville, AR, USA

Description:
Developing the knowledge, skills, abilities, and attitude to work in a globalized world is a curricular imperative of universities. Horticulture curriculum should not be excluded from higher education goals of global competence and are well poised by nature of the disciplines and career fields to provide international education and opportunities for students thereby increasing the cultural competence.

This workshop is presented by horticulturists with significant teaching, research, and outreach in international areas. The presenters will share philosophies, teaching ideas and real-world experiences in teaching in a global context. Workshop attendees will participate in round-table discussions and sharing activities to share both pitfalls and best practices of internationalized horticultural learning experiences.

8:00 AM – 8:10 AM

Welcome to the Workshop and Expectation Setting

Curt R. Rom*, University of Arkansas

8:10 AM – 8:25 AM

Planting the Seeds; The Compelling Case for International Education and Study Abroad within a Horticulture Curriculum

Ann Marie VanDerZanden*, Iowa State University

8:25 AM – 8:40 AM

Cultivating Transformation; Creating the Right Learning Experience in the Right Place for the

Right Reasons
Brian W. Trader*, Longwood Gardens

8:40 AM – 8:55 AM

Sharp Tools and Protective Gear; Learning, Well-Being and Safety in Horticulture Study Abroad
Carolyn W Robinson*, Auburn University

8:55 AM – 9:10 AM

Both inside and out; International Horticulture in the Classroom and in the Field
Carl Motsenbocker*, Louisiana State University AgCenter

9:10 AM – 9:25 AM

Harvesting the Ideas: Observations and Key Points from the Presentations
Curt R. Rom*, University of Arkansas

9:25 AM – 9:40 AM

Questions for the Panelists

9:40 AM – 9:55 AM

Roundtable Discussions

RosBREED: Combining Disease Resistance with Horticultural Quality in New Rosaceous Cultivars *CEU Approved*

Coordinator: Cameron Peace
Washington State University, Pullman, WA, USA
Moderator: Cameron Peace
Washington State University, Pullman, WA, USA

Description:
RosBREED: Combining Disease Resistance with Horticultural Quality in New Rosaceous Cultivars

8:00 AM – 8:15 AM

Rosbreed: Sustaining Success in DNA-Informed Breeding Impacts for Rosaceae
Amy F. Iezzoni*[1]; Nahla Bassil[2]; Michael Coe[3]; Chad E. Finn[4]; Ksenija Gasic[5]; Stan C. Hokanson[6]; James J Luby[6]; Dorrie Main[7]; James R. McFerson[8]; John Norelli[9]; Cameron Peace[7]; Vance M Whitaker[10] and Chengyan Yue[6], (1)Michigan State University, (2)USDA-ARS Corvallis, (3)Cedar Lake Research Group, (4)USDA-ARS HCRU, (5)Clemson University, (6)University of Minnesota, (7)Washington State University, (8)Washington State University, TFREC, (9) USDA-ARS, (10)University of Florida
Breeders of crops in the Rosaceae family (including almond, apple, apricot, blackberry, peach, pear, plum, raspberry, rose, strawberry, sweet cherry, and tart cherry) aim to develop new cultivars that combine both disease resistance and improved horticultural quality. In many cases, breeders are using resistance from wild and/or unadapted germplasm, and as a result, few have achieved commercial success because of difficulties in breeding cultivars with both excellent fruit quality and disease resistance. RosBREED, a USDA-NIFA- SCRI CAP project, addressed this need through a national coordinated effort that is enabling breeding programs of U.S. rosaceous crops to routinely apply modern genomics tools for efficient and effective delivery of cultivars with producer-required disease resistance and market-essential horticultural quality. Strategies used in the RosBREED project to build a base of genetic knowledge and translate this knowledge into breeding application will be presented.

Specified Source(s) of Funding: This project was supported in part by the USDA-NIFA-Specialty Crop Research Initiative project, RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars (2014-51181-22378).

8:15 AM – 8:30 AM

Trait Prioritization: Informing Where to Focus Resources
Zongyu Li[1]; R. Karina Gallardo[2]; Vicki A. McCracken*[1]; Chengyan Yue[3]; Vance M Whitaker[4]; James R. McFerson[5]; Gregory L. Reighard[6] and Ksenija Gasic[6], (1)Washington State University, (2)WSU - Puyallup Research and Extension Center, (3)University of Minnesota, (4)University of Florida, (5)Washington State University, TFREC, (6) Clemson University
Rosaceous crop growers are challenged to grow cultivars that are disease resistant, yet meet the fruit quality needs of various supply chain members (i.e., packers, shippers, and final consumers). Breeders face the task of developing new cultivars that effectively combine production and consumer-oriented traits. Economic experiments were used to investigate how peach growers in the southeast (in 2016 and 2018) and strawberry growers in Florida (in 2016) value disease resistance traits versus fruit quality traits. In addition to the experiment, socio-economic and demographic information was obtained from the growers. The mixed logit models indicate that results are crop specific: in the 2016 survey peach growers valued disease resistance more than fruit quality traits (size and external color) but in the 2018 survey peach growers valued fruit quality trait (external color) more than disease resistance; and strawberry growers (irrespective of the size of their operation) have strong preferences for the specific attributes of flavor improvement, size of fruits, and disease resistance from root and crown rot. Also, larger strawberry growers are more likely to grow a new cultivar with disease resistance and fruit quality improvement. The crop and trait specific results are useful to breeders in focusing time and monetary resources in their breeding programs.

8:30 AM – 8:45 AM

Data Access and Use: From Rosbreed Data Management to Genomic Prediction

An asterisk (*) in front of a name indicates the presenting author.

Dorrie Main*[1]; Sook Jung[1]; Cameron Peace[1]; Nahla Bassil[2]; Craig M. Hardner[3]; James R. McFerson[4]; Amy F. Iezzoni[5]; Taein Lee[1]; Chun-Huai Cheng[1]; Heidi Hough[1]; James J Luby[6]; Ksenija Gasic[7]; Jodi L. Humann[1]; Daniel Edge-Garza[7]; Jason Zurn[8]; Lisa Wasko DeVetter[9]; Kate Evans[1]; Audrey Sebolt[5]; Stijn Vanderzande[1] and Michael Coe[10], (1) Washington State University, (2)USDA-ARS Corvallis, (3) University of Queensland, (4)Washington State University, TFREC, (5)Michigan State University, (6)University of Minnesota, (7)Clemson University, (8)USDA-ARS NCGR, (9)Washington State University Northwestern Washington Research and Extension Center, (10)Cedar Lake Research Group
For the last decade RosBREED project participants have been generating and analyzing large amounts of phenotypic and genotypic data for both discovery and translation in Rosaceae breeding. We highlight how these data has been managed, what tools have been developed in the Genome Database for Rosaceae to enable access and use of this data and what news tools are being developed to enable global genomic prediction of performance.

Specified Source(s) of Funding: USDA NIFA SCRI GDR, RosBREED and NRSP10 awards

8:45 AM – 9:00 AM

Successes in Pre-Breeding: Pyramiding and Combining Multiple Disease Resistances

John Norelli*[1]; Cameron Peace[2]; Feixiong Luo[2]; Roger Lewis[1]; Jack Klipfel[2]; Daniel Edge-Garza[2]; Henryk Flachowsky[3]; Magda-Viola Hanke[3] and Michael Wisniewski[1], (1)USDA-ARS, (2)Washington State University, (3)Julius Kuehn Institute
The long generation time of apple (*Malus pumila* Mill.) has made the development of new cultivars with pyramided disease resistance alleles to multiple diseases difficult to achieve. Furthermore, because the presence of a single resistance allele can phenotypically mask the presence of additional alleles, pyramiding resistance alleles by traditional phenotyping methods can be challenging or impossible. Ectopic expression of a *FRUITFUL* homolog (*BpMADS4*) from silver birch (*Betula pendula* Roth) reduces the juvenility of apple from 3-7 years to 3-8 months. Since the *BpMADS4* transgene behaves genetically as a single dominant allele at a heterozygous locus, it segregates 1:1 in subsequent crosses such that 50% of the resulting population will carry the *BpMADS4* transgene for reduced juvenility, and 50% will be non-transgenic with normal growth and juvenility. Individuals carrying the *BpMADS4* transgene are initially selected to facilitate accelerated breeding during the pyramiding of desirable alleles at multiple trait loci. After achieving the desired allele accumulation, non-transgenic individuals without the *BpMADS4* transgene but retaining the desired trait alleles are selected. Our goal in RosBREED was to pyramid both scab (*Venturia inaequalis*) and fire blight (*Erwinia amylovora*) resistance alleles in apple breeding parents. DNA-informed breeding methods, rather than traditional phenotyping methods, were used to identify individuals with multiple alleles for disease resistance and elite fruit quality. Disease resistance alleles and the *BpMADS4* transgene were actively selected using locus-specific DNA tests in Marker-Assisted Seedling Selection (MASS). Following MASS of progeny for the targeted alleles, seedlings were evaluated by Marker-Assisted Parent Selection (MAPS) using a panel of DNA tests for important fruit quality traits developed in RosBREED. Individuals to advance to the next generation were identified based on their overall allele composition in MAPS rather than by the presence of specific fruit quality alleles. Similar methodology was used to introgress resistance to post-harvest apple blue mold from *M. sieversii* PI613981 into apple breeding parents with other pyramided disease resistance alleles. To achieve efficient introgression of the blue mold QTL, however, MASS individuals were genotyped on apple 20K Illumina SNP array to identify favorable recombination events near the blue mold QTL and quantify undesirable DNA segments from PI613981. The development of breeding parents containing pyramided alleles for resistance to apple scab and fire blight along with many desirable fruit quality traits, will allow breeders to obtain new cultivars with a desired suite of resistance alleles from one cross rather than from multiple crosses over many generations.

9:00 AM – 9:15 AM

Impact on Apple Breeding: DNA Markers Inform Cross Planning and Parent Selection

James J Luby*[1]; David S. Bedford[1]; John Tillman[1]; Nicholas P. Howard[1] and Cameron Peace[2], (1)University of Minnesota, (2)Washington State University
Development of genomic tools and knowledge of important trait loci in breeding program germplasm has enabled systematic use of DNA marker information to plan crosses and select parents in the University of Minnesota apple breeding program. Routine SNP array scans of new selections and prospective parents, along with genotype data on pedigree ancestors, permit deduction of genome-wide haplotypes and predicted breeding values at over a dozen loci controlling key fruit quality traits and apple scab resistance. Breeders annually examine predicted breeding values as well as phenotype and pedigree information in planning crosses to achieve breeding targets. Careful selection of parents based on DNA information potentially reduces the need for more expensive DNA marker-based seedling selection and also helps identify crosses in which such selection may be desired.

9:15 AM – 9:30 AM

Impact on Strawberry Breeding: Genome-Wide Selection in Practice

Vance M Whitaker[1]; Luis Osorio*[1]; Salvador A. Gezan[1]; Rex Bernardo[2] and Sujeet Verma[1], (1)University of Florida, (2)

University of Minnesota
Genome-wide selection (GWS) is being increasingly utilized in animal and plant breeding to improve genetic gains for polygenic traits, but implementation has generally lagged behind in fruit breeding programs. The strawberry breeding program at the University of Florida began exploring this methodology five years ago as part of the RosBREED project, using trials of advanced selections to train statistical models that were validated in future years trials. In 2015, GWS for parent selection was integrated into the breeding program. Since that time, various improvements in methodology have been implement, and practical applications have been made. First, prediction of genomic expected breeding values of first-year seedlings, prior to their inclusion in clonally replicated trials in the following year, allowed early parent selection for a subset of crosses. This is accomplished in practice by genotyping advanced selections several months prior to their inclusion in clonally replicated trials, generating performance predictions for multiple traits, and selecting a few predicted top-performers for immediate inclusion in crosses. This has increased genetic gains for traits such as fruit size and soluble solids content by reducing the average length of the breeding cycle. Second, once phenotypic data is available, the prediction of breeding values is now done with marker-based relationship matrices instead of pedigree data. This translates into estimates of genetic values with higher precision. Third, phenotypic and marker data from each year has been added to the training population to predict genetic values for the subsequent cycle. This increases the size of the training population each cycle, which has resulted in higher predictive abilities leading to higher genetic gains. Fourth, recent research on GWS to choose the best seedlings from biparental crosses has been successful. Not only are substantial genetic gains above family means possible, but only 500 markers are needed. Thus, within-family seedling GWS can be implemented to increase genetic gains for polygenic traits if cost-effective, low-density genotyping can be developed for strawberry.

9:30 AM – 9:45 AM

Impact on Peach Breeding: Elite Selections Combining Disease Resistance and Superior Fruit Quality

Ksenija Gasic*; Ralph Burrell III; Cassia Da Silva Linge and Wanfang Fu, Clemson University

Combining disease resistance with superior fruit quality and climate resilient productivity is a new standard in peach breeding programs. As a result of the foundational knowledge and tools generated in RosBREED,breeders are no longer relying solely on phenotyping and serendipity but are in many cases equipped with the DNA based information when designing crosses and choosing offspring to advance. The Clemson University peach breeding program aims to combine brown rot (*Monilinia spp.*) and bacterial spot (*Xanthomonas syringae pv. pruni*) disease resistance in large, yellow flesh, melting, fresh market peach cultivars with improved climate resilience. This is easier said than done. Phenotypic data coupled with available DNA information on disease resistance and fruit quality is the main driver when designing crosses to maximize the proportion of offspring with favorable traits. A DNA test for fruit response to bacterial spot infection, developed in RosBREED, is routinely used to cull seedlings prior to planting in the field. Sources of resistance for brown rot are horticulturally inferior and development of DNA test(s) is hindered by polygenic inheritance of many genes with small effect. Thus, genomic prediction is being validated in choosing parental combinations and culling offspring. A roadmap to elite selections with confirmed superior horticultural quality and bacterial spot and brown rot tolerance using a combination of molecular and phenotyping approaches in Clemson University peach breeding program will be presented.

9:45 AM – 10:00 AM

Sustaining Success: The Planned Legacy of Rosbreed

James R. McFerson*, Washington State University, TFREC

The two RosBREED projects funded through the NIFA-SCRI program were unprecedented in project scale, scope of work, team diversity and breadth of deliverables. As Coordinated Ag Projects, both RosBREED 1 and 2 involved multiple public and private sector participants, nationally and internationally. With a broad scope from genetic discovery to cultivar improvement, the projects took a whole systems approach, addressing challenges in Production, Distribution & Processing and Consumer & Markets, with active Advisory Panels representing each of the areas. Over 60 scientists from an array of U.S. and foreign institutions have participated as team members. Deliverables from both projects include an array of technical advances adding to our knowledge base and directly informing useful DNA tests now available through public and private sector providers to rosaceous breeding programs. Training and networking opportunities for graduate students and postdocs within the two projects has provided a significant cohort of the next generation of plants breeding and genetic scientists. Finally, rosaceous crop stakeholders actively participated in both projects and continue to strongly support the numerous spin-off projects building on the legacy of RosBREED.

Specified Source(s) of Funding: USDA-SCRI-NIFA

Introduction to ASHS Undergraduate Activities and Sessions

Description:
In this session undergraduate students will be introduced to what the national ASHS conference has to offer them. Students will be welcomed, introduced to the various un-

dergraduate contests sponsored by ASHS and encouraged to make the most of each opportunity presented at the conference.

Plenary Session & ASHS Awards Ceremony

Description:
Dr. Norman Lownds, Director of the Children's Garden at Michigan State University, will deliver the Tex Frazier Lecture on the educational aspects of the garden for school children of all ages.

Seeds of Science: Connecting Kids, Plants and Science in the Michigan 4-H Children's Gardens

(Poster Board #)
Norman Lownds*, Michigan State University
Gardens, especially children's gardens, can be powerful, interactive spaces that connect kids to plants and science in exciting ways that will carry through their learning and life. Join Dr. Lownds on a walk (run) through the Michigan 4-H Children's Gardens and the educational programs developed over the past 25 years. Explore how kids 'experience plants' in multiple ways, how they use technology to enhance and expand their hands-on learning and how they become immersed in "authentic experiments". Discover how the learning connects all the way back to Liberty Hyde Bailey's Nature Study Idea; what that looks like in 2019; how it all connects with the Next Generation Science Standards; and how it can provide important NSF Broader Impacts. Be inspired by reactions to Seeds of Science field trips and the impact they have on student interest, engagement and learning. Gather up ideas that can be used to interest and engage the next generation and develop a connection to, and love of, plants. Let the kid in you get excited by plants all over again!

The 4-H Children's Gardens at Michigan State University have been engaging and exciting visitors for over 25 years. This garden has been described as "the most creative half-acre in America" and "a magical place of learning". The gardens encourage visitors to 'experience plants' in the garden by smelling, touching and even tasting them. Children connect to plants through a variety of theme gardens including The ABC Kinder Garden, with plants that start with every letter of the alphabet; The Perfume Garden, with plants that smell great; The Science Discovery Garden, with plants that are being studied by researchers in Horticulture and The Pizza Garden, with plants that are used to make your pizza. In addition, kids can cross the Monet Bridge, wander through the Alice in Wonderland Maze and make music on the Dance Chimes. Visitors and can also explore plants in the Pete & Sally Smith Schoolyard Demonstration Garden and the Indoor 4-H Children's Garden. Visitors come for a visit and leave with new and lasting connections to plants. It truly is "a magical place of learning".

Conference Overview Session - For Graduate and Undergraduate Students

Coordinators: Kimberly Moore
University of Florida/IFAS, Fort Lauderdale, FL, USA
David Kopsell
Illinois State University, Normal, IL, USA

Description:
This session will provide the essential information for how to get the most out of your attendance at the ASHS Annual Conference. Specific events, sessions and competitions that have designed for students will be explained. ASHS staff and volunteers will be on hand to make sure that you are aware of all that ASHS and specifically the ASHS Conference has to offer specifically for students (both undergraduate and graduate).

12:00 PM – 12:10 PM

How Best to Maximize Your Time at the ASHS Conference

David Eliot Kopsell*, Illinois State University

12:10 PM – 12:20 PM

You Are Here, Make the Best of It!

Kimberly Moore*, University of Florida/IFAS

12:20 PM – 12:30 PM

Have Fun but You Are Here for the Conference

Lorenzo Rossi*, University of Florida

12:30 PM – 12:40 PM

Student Perspective

Sean Campbell*, Univ of Florida

Tips for Publishing with ASHS

Moderators: Paul Bosland
New Mexico State University, Las Cruces, NM, United States
Neal De Vos
De Vos & Associates, Watsonville, CA, United States

Description:
Come ask your questions and get tips from the ASHS Editors in Chief related to publishing in the ASHS Journals.

Private Sector Perspectives in Small Fruit Breeding *CEU Approved*

Coordinator: Margaret Worthington
University of Arkansas, Fayetteville, AR, USA
Moderator: John Clark
University of Arkansas, Fayetteville, AR, USA

Description:
The landscape of fruit breeding is rapidly changing. Fruit breeding programs in the private sector are developing

a larger percentage of important new cultivars than ever before. The goal of this workshop is to give private sector small fruit breeders an opportunity to share their perspectives on challenges and opportunities in our industries. Panelists representing a broad range of small fruit commodities, large and small companies, and career experience levels will each give a brief presentation about what contributed to their career choice and then share information on their breeding program and its major objectives. These introductory presentations will be followed by a moderated panel discussion on private sector perspectives in fruit breeding covering topics related to intellectual property and access to varieties, breeding for global market and diverse environments, and use of genomic breeding strategies in the private sector. Participant speakers sharing perspectives on careers in private breeding, particularly compared to public career opportunities.

1:00 PM – 1:15 PM

Panelist: Private Sector Perspectives in Fruit Breeding

David W Cain*, IFG

1:15 PM – 1:30 PM

Panelist: Private Sector Perspectives in Fruit Breeding

Jessica Lilia Gilbert*, Driscoll's

1:30 PM – 1:45 PM

Panelist: Private Sector Perspectives in Fruit Breeding

Philip Stewart*, Driscoll Strawberry Associates

Research Status of Controlled Environment Agriculture, Discussion of Challenges and Opportunities: International and National Perspectives *CEU Approved*

Coordinator: Ricardo Hernandez
NC State University, Raleigh, NC, USA

Moderator: Ricardo Hernandez
NC State University, Raleigh, NC, USA

Description:

The use of controlled environments (CE) either in the form of greenhouses or vertical farms has increased in terms of adoption around the world and also in terms of investment into the commercial sector.Even though there is a renewed interest in producing plants in controlled environments, there are still several scientific, economic, environmental, and production challenges. In addition, misinformation about the sustainability and capabilities of these systems still remains. Since this is a worldwide movement, several research programs around the world are currently executing research to address the challenges of commercial controlled environment production systems. The leading research countries include the Netherlands, Japan, Canada, China, US among others. The intent of this workshop is to have an exchange of information of the research efforts around the world.

The workshop will have two presentations from international speakers and one presentation from a national speaker. After presentations, two more panelists will join the invited speakers for the discussion session.

In order to facilitate audience participation and to create a dynamic interaction between the panelists and the audience, a debate format will be followed:

1. The audience will have the opportunity to ask a "bigger picture" question.

2. We encourage that up to two of the panelists answer the question, each panelist will have a buzzer (light) in front of them and the first two panelist that activate the buzzer will have 2 minutes to answer the question. If after 5-10 seconds no "buzzers" are activated, we will move to the next question. This format will allow for limited time per question and increase the number of discussion points.

1:00 PM – 1:05 PM

Introduction and Workshop Logistics

1:05 PM – 1:20 PM

Full Control of Production and Quality of Plants Grown in Vertical Farm

Leo Marcelis*, Wageningen University

1:20 PM – 1:35 PM

Engineering, Physiology, and Biotechnology: Research Efforts toward Next-generation Controlled Environment Agriculture

Ryo Matsuda*, The University of Tokyo

1:35 PM – 1:50 PM

Closed Controlled Environment Energy Savings with New Genetics and Pulsed Light Treatments

Kevin M Folta*, University of Florida

1:50 PM – 1:55 PM

Introduction of Panelists

Chieri Kubota, The Ohio State University and Bruce Bugbee, Utah State University

1:55 PM – 2:30 PM

Discussion

Chieri Kubota*, The Ohio State University

An asterisk (*) in front of a name indicates the presenting author.

2:30 PM – 2:45 PM

Discussion

Bruce Bugbee*, Utah State University

2:45 PM – 3:00 PM

Discussion

Ricardo Hernandez*, NC State University

Advocating for Horticultural Research and Extension When You Are Far from Washington

Coordinator: Thomas Björkman
Cornell University, Geneva, NY, USA

Objectives: ASHS members play an important role in maintaining public support for the work we do by advocating with local politicians and their staffs. While the West can feel far from DC, local action is critical to maintaining support and awareness. This session will help members better understand how to do their part confidently and effectively.

Description:
Funding for horticultural research and extension comes from many levels of government. Each one is important and has a specific public purpose. Each one requires continuous justification. Those of us who use those funds to benefit the public need to be part of the ongoing effort to make sure that these funding programs are understood and supported.

This program will be an interactive session to help participants engage locally. Our venue so far from Washington DC reinforces the importance of action in the place where the work gets done. Federal, state and county representatives all have distinct roles. District staff, who usually do constituent services, also contribute to policy work. Effective advocates know the individual politicians and staffers and understand their role in supporting our work, and addresses them accurately. Local politics depends a lot on personal relationships and local history unrelated to any specific issue. Stories of how that plays out in Nevada provide examples that apply anywhere.

1:00 PM – 1:15 PM

Introduction

Thomas Björkman*, Cornell University

1:15 PM – 1:30 PM

Speaker

Angela M. O'Callaghan*, University of Nevada

Application of Automation Technologies for Horticultural Crop Production: Challenges and Opportunities *CEU Approved*

Coordinators: Shinsuke Agehara
University of Florida, Gulf Coast Research and Education Center, Wimauma, FL, USA
Brian Ward
Clemson University CREC, Charleston, SC, United States
Qingren Wang
University of Florida/IFAS Extension Miami-Dade County, Homestead, FL, USA
Moderator: Shinsuke Agehara
University of Florida, Gulf Coast Research and Education Center, Wimauma, FL, USA

Description:

Overview

Horticultural crops require intensive management, inputs, and labor. Unlike agronomic crops, many horticultural crops are harvested by hand and require intense and constant care, such as pruning, weeding, disease and pest control, irrigation, and fertilization. On average, hand harvesting of fruit and vegetable crops accounts for about 50% of total production costs. With decreasing labor availability and increasing production and labor costs, automation is becoming increasingly important to maintain the profitable production of horticultural crops. Automation technologies can be implemented in many farming operations including harvesting, weed control, disease and pest control, and field scouting. They can also be integrated with other advanced technologies (e.g. drones, artificial intelligence, internet of things, etc.) to create new farming-assistant tools, such as yield forecasting and plant stress detection. Therefore, automation technologies have the potential to not only reduce labor and input costs, but also improve crop productivity, management, and production efficiency. This workshop will focus on discussing key challenges and opportunities in implementing automation technologies in farming operations for horticultural crops.

Objectives

Workshop participants will gain: 1) up-to-date information on the current state of automation in various farming operations, 2) understandings on the potential of automation technologies to revolutionize the horticultural industry, 3) information on the current and emerging application of automation technologies, research questions, challenges, and opportunities, 4) a greater familiarity with industry and scientific communities involved in precision agriculture and automation technologies, and 5) networking opportunities for potential collaboration.

Program

- Part 1 (60 min) has 9 presentations, which will provide synopses on various automation technologies including unmanned aerial vehicles, plant stress sensing, disease detection, precision weed control, harvesting robotics, and yield forecasting.

- Part 2 (30 min) is a moderated group-wide discussion focusing on challenges and opportunities in automation technologies for the horticulture industry.

- Part 3 is a supplementary session at an exhibitor booth (VCM/SSEST Interest Groups: Automation Technologies for Horticultural Crop – joint exhibit booth by Vegetable Crops Management and Seed and Stand Establishment Interest Groups) during the ASHS conference. We will use multimedia and display automated equipment and devices to provide interactive, hands-on learning opportunities.

3:15 PM – 3:17 PM

Introductory Remarks

3:17 PM – 3:24 PM

Small Unmanned Aircraft System (sUAS) for Agricultural Users Identification

Joe Maja*, Clemson University

The overall goal of the presentation is to introduce attendees to small unmanned aircraft systems (sUAS). It is estimated that more than 80% of commercial sUAS users will be in agriculture. This presentation will focus on risk-based information for current and future commercial users of this emerging technology. It will include presentations on aircraft systems and workflow since most initial users are uneasy about the technology. Participants should achieve an improved understanding of flight regulations, types of platforms & sensors, data processing, and potential agricultural uses. Participants will also make improved decisions to match the best sUAS with their needs or operations.

3:24 PM – 3:31 PM

Application of Small Unmanned Arial System (sUAS) in Vegetable Cop Management

Qingren Wang*, University of Florida/IFAS Extension Miami-Dade County

The presentation is to display a small Unmanned Arial System (sUAS) in promoting vegetable crop management. The device is DJI Phantom 4 Pro associated with a multispectral sensor – double 4k developed by Sentera specifically for agriculture. A number of vegetable crops have been surveyed with digital images collected and processed. The data can provide timely information to growers for their decision-making to reduce the yield losses.

3:31 PM – 3:38 PM

Robotic Weeders: A Better Way to Develop New Weed Control Technology for Vegetable Crops

Steven A. Fennimore*, University of California, Davis

There are few new herbicides for vegetable crops, and it has always been difficult to find new weed control materials for these crops. Vegetable crops are not a priority for the agrochemical industry, and many of these crops do not have access to effective herbicides. High-value fruit and vegetable crops represent small markets and high potential liability in case of herbicide-induced crop damage. Hand weeding of vegetables has been necessary to realize acceptable weed control. Labor shortages may eliminate this option for specialty crop producers in the not too distant future. Robotic weeders are promising new weed control tools for specialty crops. Now is the time for greater investment in robotic weeders as new herbicides are expensive to develop and few in number, and organic crops need better weed control technology as well. Fundamental research on robotic weeder technology can help improve weed and crop recognition, as well as weed control actuators. Weed science curricula must begin to train students in this technology if they are to meet the future demands of industry. Robotic weeders expand the array of tools available to vegetable crop growers and can reduce handweeding times 30 to 40%. However, the development of robotic weeders will require a broader recognition that these tools are a viable path to create new weed control tools for specialty crops so that they get the resources they deserve.

3:38 PM – 3:45 PM

Utilization of Husky Robotics Platform for Weed Control

Matthew Cutulle*, Clemson University

Limited herbicide options are available for use in specialty crops due to their small markets and high potential liability in the case of herbicide crop damage. Robotic weeders can provide a solution for weed management in specialty crops. Tractor mounted smart cultivators have had some success in California. However, that type of technology may not be affordable for small diversified growers in the coastal Carolinas. Additionally, the higher and less predictable rainfall in the southeast makes it more difficult to rely on frequent cultivation for weed control with larger implements. The Husky robotics platform utilizes a light weight UGV with both a precision spray actuator and mechanical weeding device, which allows for improved performance in wet soils and has a base price of $20,000.

3:45 PM – 3:52 PM

Adaption of Mobile Robot Platform for Cotton Harvesting

Joe Maja*, Clemson University

Robots are becoming more integrated into the manufacturing industry. Though most of the manufacturing environment is not as complicated as outdoor, recent advances on sensors and algorithm provide an interesting outlook on how robots will be working outdoor with humans. Commercial small unmanned ground vehicle (UGV) or mobile ground robots with navigation sensing modality provides a platform to increase farm management efficiency. The platform can be retrofitted with different manifolds that perform a specific task, e.g., spraying, scouting (having multiple sensors), phenotyping, harvesting, etc. This presentation will focus

An asterisk (*) in front of a name indicates the presenting author.

on the robot prototype being used for selective harvesting of cotton. Autonomous map-based robot navigation will be presented including the initial result for selective harvesting experiment. The mobile robot was retrofitted with a vacuum-type system with a small storage bin. A video of the performance test on navigation and harvesting will be presented.

3:52 PM – 3:59 PM

Automating Strawberry Harvest

Yiannis Ampatzidis*, University of Florida

Fresh-market strawberries are very perishable, and virtually 100% are hand-harvested. Strawberry growers face increasingly tighter labor supplies, driving up harvest costs and increasing the risk of labor shortages to complete a full harvest. A mechanical harvest technology could simultaneously lessen growers' dependence on manual labor, reduce harvesting costs, and improve their overall competitiveness. Herein, we present several mechanical strawberry harvest solutions for most commercially grown varieties. Some technologies do not require growers to radically change the way they currently grow strawberries, and they can solve the urgent labor shortage problem.

3:59 PM – 4:06 PM

Some Robotic Technologies for Strawberry Fields

Yunjun Xu*, University of Central Florida

In strawberry field operations, activities such as harvesting and disease/nutrient deficiency detection are labor intensive. In this talk, we will discuss several tools been developed to enable robotic operations for those labor intensive activities. (1) A vision based robust controller is developed for field robot scouting. (2) An algorithm is studied to differentiate green and yellow leaves in different lighting conditions. (3) A new image processing tool is investigated to detect nutrient deficiencies. (4) A real-time, suboptimal method is experimented for leaf picking.

4:06 PM – 4:13 PM

Using Canopy Features Extracted from High-Resolution Imagery to Assist Strawberry Research and Production

Amr Abd-Elrahman*, University of Florida

High-resolution image acquisition technologies are becoming increasingly ubiquitous. This presentation introduces different methods to analyze the geometrical information of strawberry canopies to assist different aspects of strawberry farming. The presentation will demonstrate and discuss how canopy size metrics such as canopy area, volume, and height, as well as flower and fruit counts are extracted from the images and how they can be utilized in various applications including strawberry yield modeling.

4:13 PM – 4:45 PM

Discussion

Evaluation and Utilization of Germplasm for Improving Plant Resistance to Drought and Heat Stresses *CEU Approved*

Coordinator: Wenhao Dai
North Dakota State University, Fargo, ND, USA
Moderator: Wenhao Dai
North Dakota State University, Fargo, ND, USA

Description:
Drought and heat are two major environmental stresses in agriculture, causing reduced crop yield and quality. Many horticultural crops are grown in the regions that frequently receive high temperatures and many of these regions have no sufficient water source; therefore frequent drought and heat limit plant growth and development. Researchers have been making efforts to mitigate drought and heat stresses in crop production. Plant breeders consider drought and heat resistance one of the major breeding goals. Because germplasm is the lifeblood of plant breeding, breeders are always seeking elite plant germplasm to develop novel plant materials with desired traits. Advances in understanding mechanisms of plant responses to drought and heat stresses using molecular genetics and genomics approaches would help breeders improve the breeding efficiency. The goal of the proposed workshop is to bring together the best science on evaluation and utilization of germplasm to improve plant resistance or tolerance to drought and heat stresses. The workshop will also present research updates on different aspects of plant response to drought and heat stresses. Speakers/panelists will be asked to emphasize on the research strategies used; therefore, participants will have chance to understand and learn some hands-on techniques that would be applied to their own research. The workshop panel consists of a group of multidisciplinary specialists representing the research field of plant breeding, plant stress physiology, and molecular genetics and genomics, covering both woody and herbaceous species.

3:15 PM – 3:28 PM

Combating Drought and Heat Stresses in Crop Production

Wenhao Dai*, North Dakota State University

Drought and heat are two major environmental stresses impacting crop productivity. In agriculture, drought is mainly caused by fewer rainfalls with a period of high temperature; therefore drought and heat are often associated. Drought and heat limit crop growth and development, resulting reduced yield and poor quality. In severe cases, drought and heat may cause plant death. Horticulture is one of the biggest water consumers in agriculture and many horticultural crops are grown in the regions that frequently receive extreme high temperatures and limited rainfalls. Many regions, particularly in developing countries, have very limited water sources and irrigation capacity; therefore drought and/or heat stresses might be one of the major risks of food security. Differential responses of plant species to abiotic stresses indicate that plants have possessed the mechanisms to deal with different stresses. Researchers have been making every effort to understand the mechanisms plants developed to respond drought and heat, which certainly help develop novel plant materials and strategies to combat these two stresses. In the presentation, responses of plants, particularly in horticultural species, to drought and heat and their management strategies will be reviewed.

3:28 PM – 3:30 PM
Introductory Remarks

3:30 PM – 3:45 PM
Progress and Challenges in Breeding Broccoli Adapted to High Temperature Environments
Mark W Farnham*, USDA-ARS
ARS scientists in Charleston, SC have been working to breed broccoli adapted to high temperature environments for more than two decades. This effort has employed a recurrent selection approach, and progress in developing germplasm increasingly tolerant to this abiotic stress has been slow and incremental. Observations and experience over the years have confirmed the original hypothesis that adaptation to high temperatures is a quantitative trait controlled by many genes with relatively small effects. Recent studies have identified significant quantitative trait loci (QTL) associated with the trait, and candidate genes that may be associated with expression have been proposed. Research has also identified factors that may limit additional gains made in this breeding effort; however, some progress can still be expected in future selection cycles.

3:45 PM – 4:00 PM
Tapping into the Diversity of Wild Relatives and Domesticated Carrot to Improve Heat and Drought Stress
Philipp W Simon*, USDA

4:00 PM – 4:15 PM
Screening Tomato (Solanum lycopersicum L.) for Heat Stress Tolerance
Dilip R. Panthee*, North Carolina State University
The growing evidence of global warming and, its potential impact on crop production has prompted several physiological and genetic analyses under high-temperature conditions. Optimum growing temperatures for tomato (*Solanum lycopersicum* L.) is less than 32°C and 24°C during day and night, respectively. Tomato is grown in sub-tropical and tropical regions of the world, where day and night temperatures exceed the optimum temperatures during summer which exerts potential heat stress on tomato production. With looming global warming, the temperature levels may go up even further. As a first step of improving tomato for heat stress tolerance, we performed the heritability estimate analysis for heat stress tolerance. From the same populations, we continued screening for heat stress tolerance with an objective of developing tomato lines with improved heat stress tolerance and fruit quality. Heat stress tolerance measured in terms of number of flowers and fruits per plant, and fruit setting index indicated that these traits have been improved significantly. Improvement was also made in fruit size, fruit smoothness, and blossom end rot in tomato lines. These are the encouraging progress towards the development of a new variety of tomato with improved heat stress tolerance and fruit quality.

4:15 PM – 4:43 PM
Discussion

4:43 PM – 4:45 PM
Concluding Remarks

Potential Policy Impacts on Specialty Crop Production in Horticulture: A Perception Approach *CEU Approved*

Coordinator: Alicia Rihn
University of Florida, Apopka, FL, USA
Moderator: Alicia Rihn
University of Florida, Apopka, FL, USA

Description:
Policies are continually being updated and can influence all aspects of ornamental horticulture from production practices to promotions. The workshop explores and discusses issues related to different policies in specialty crop horticulture. Presentations will feature different perceptions of policies related to trending topics (technology adoption, specialty crop risk mitigation tools, industrial hemp, pesticide labeling, and sustainability) and how policies related to these topics may impact the success of specialty crops.

3:15 PM – 3:20 PM
Introductory Remarks

3:20 PM – 3:35 PM
Risk Preferences of Commodity Crop Producers and Specialty Crop Producers
Shouli Zhao; Chengyan Yue* and Xiangwen Kong*, University of Minnesota
Producers' decisions such as crop insurance, contract agreement, and technology adoption, involves considerable risk and uncertainty. Particularly, specialty crop production is more vulnerable to risk and requires more intensive management than commodity crop production, while risk mitigation tools are comparatively limited. We analyze risk preferences of US producers, and further compare the preference differences between commodity crop and specialty crop producers. We find certain farm characteristics and producer demographics have a significant impact on pro-

ducer risk attitudes. Additionally, the relationships between risk behavior and individual characteristics vary between the two types of producers, which shed lights on agricultural policies and provides implications for the design of contract and insurance.

3:35 PM – 3:50 PM

Enacting Policies to Ban Pesticides in Greenhouse and Nursery Production

Ben Campbell*, University of Georgia

Many consumers have begun to question and/or advocate for the banning of pesticides in the production of their food. As such, it is most likely the case that consumers would want pesticides to be eliminated from other products they purchase. Using data from a 2019 online study, we examine consumer sentiment toward enacting policies that would ban pesticide use in greenhouse and nursery production.

3:50 PM – 4:05 PM

Value-Added Technologies in the Specialty Crop Industry

Ariana P Torres*, Purdue University

Adding value to the crop mix allows farmers to increase revenues and diversify their income sources. This study presents the value-added technologies adopted by specialty crops growers in the U.S. I will also examine the main drivers and barriers influencing adopting technologies, suggest needs for future research.

4:05 PM – 4:20 PM

Consumer Views on the Legalization of Hemp Production

Julie Campbell*; Adam Rabinowitz and Ben Campbell, University of Georgia

Until recently industrial hemp production in the U.S. has been illegal at the federal level. The 2018 Farm Bill legalized the production and distribution of industrial hemp and hemp related products. Using a 2019 online survey we assess consumer awareness and views on this policy change. Notably, we assess whether consumers agree/disagree with the legalization of industrial hemp.

4:20 PM – 4:35 PM

The Influence of Label Source and Consumer Preferences on Valuation of Eco-Labels: A Policy Perspective

Alicia Rihn*; Hayk Khachatryan and Xuan Wei, University of Florida

Eco-labels are used as signals to inform consumers about environmentally friendly products and encourage consumption of those products. Consumer valuation and demand for environmentally friendly products is increasing; however, eco-labels are very diverse which may impact their effectiveness. An online survey was used to test consumer perceptions of eco-labels, trust in source firms (e.g. private vs. public), and how those factors impact their valuation of plants. Implications to eco-label related policy will be discussed.

4:35 PM – 4:45 PM

Discussion

Tuesday July 23, 2019

Biological Seed Treatment: Recent Advances in Seed Technology *CEU Approved*

Coordinators: Shinsuke Agehara
University of Florida, Gulf Coast Research and Education Center, Wimauma, FL, USA
Xianming Duan
Sakata Seed America, Inc., Salinas, CA, USA
Tiare Silvasy
University of Florida, GAINESVILLE, FL, USA
Moderator: Shinsuke Agehara
University of Florida, Gulf Coast Research and Education Center, Wimauma, FL, USA

Description:

Overview

Biological seed treatment is a rapidly growing sector of the seed treatment industry. The global biological seed treatment market is projected to reach more than US$1.2 billion by 2022, from US$700 million in 2017. A wide variety of biological agents are used for seed treatment, including plant extracts, humic acids, amino acids, plant hormones, mycorrhizae or other beneficial microbes, and biostimulants containing mixtures of such substances. Seed treatment with these biological agents offer various modes of action, protecting seeds and seedlings from abiotic stress, diseases, and pests during their establishment – the most critical phase of crop growth.

Objectives

Workshop participants will gain: 1) information on the biological seed treatment market overview and industry trends, 2) information on current and emerging biological seed treatment products, 3) up-to-date information on seed coating technology and treatment research, 4) a shared understanding on potential benefits and importance of biological seed treatment for improving crop performance and protection, 5) a greater familiarity with industry and scientific communities involved in biological seed treatment, and 6) networking opportunities for potential collaboration.

Program

- Part 1 (60 min) has 4 presentations by industry speakers and 2 presentations by university speakers. The presentations will cover the biological seed treatment market and trend, current and new biological products, mode of action, product performance, recommendations, university research on seed coating technologies and treatments, and treatment evaluation techniques.

- Part 2 (30 min) is an interactive panel discussion designed to fill the gap among industry, research, and education on this emerging technology.
- Part 3 is a supplementary session at an exhibitor booth (VCM/SSEST Interest Groups: Automation Technologies for Horticultural Crop – joint exhibit by Vegetable Crops Management and Seed and Stand Establishment Interest Groups) during the ASHS conference. We will display the rhizotron box used for seed treatment evaluation to provide interactive, hands-on learning opportunities. One of the industry presenters (Ag BioTech) is also planning to have an exhibitor booth.

8:00 AM – 8:02 AM

Welcoming Remarks

8:02 AM – 8:12 AM

Growing Opportunities for Biological Seed Treatments on Vegetable Seeds

Xianming Duan*, Sakata Seed America, Inc.

Among the different types of agricultural biologicals potentially used for seed treatment, microbial products have been the focus of development in the industry. Although conventional fungicides have been widely used in commercial vegetable seed treatment, adoption of agricultural biological application is still in its infancy in the vegetable seed industry when compared to the major field crop corn seed. One major limiting factor has been the lack of biological seed treatments designed for vegetable seeds. In addition, previously registered products were mainly based on a single microbial strain. Recently, developments have been made on multiple microbial consortium-based seed treatment products for vegetable seeds, offering promising marketing and research opportunities. We will discuss the market potential, application methods, and uniqueness of vegetable seed requirements. Furthermore, the requirements of new approaches and methodology for future development will also be proposed.

8:12 AM – 8:22 AM

Bio Seed: The Non-Specific Inoculate to Optimize Nutrient Availability

Tristan Hudak*, Ag BioTech

Learn how this non-crop specific biological consortium, Bio Seed, has performed in greenhouse trials both as a seed treatment and root drench in 2019. With five unique microbial strains, each selected for their own role in nutrient availability, Bio Seed will work to maximize the available nutrients in the soil solution. These Gram-positive, rhizosphere competent strains have shown consistent improvements in crop yields year after year, and Bio Seed has proven to be a highly versatile and cost-effective microbial product offering to vegetable seed community.

8:22 AM – 8:32 AM

Advances in Bio-Based Seed Treatments: Seedworx Biosa and Seedworx Bioma Move Toward Uses within Horticultural Crops

Peter Marks*, AgInnovation

Seedworx BioSA, comprised of a blend of *Bacillus amloliquefaciens* and *B. subtillis* and Seedworx BioMA, comprised of a blend of *Bacillus amloliquefaciens* & *B. methyltrophicus* have had widespread testing and adoption within the broad acre seed markets, corn and soybean. With multiple years of locational testing within the Midwest, Seedworx BioSA and BioMA have shown yield enhancements under stressed conditions for those respective crops. Recent testing & trialing of Seedworx BioSA upon horticultural crops such as Leafy Greens, Brassica & Solanaceae crops by independent seed companies have seen improved plant health and yields. While the adaptation of biological seed treatments within the broad acre crops has been well accepted by growers, horticultural crop growers are gaining greater exposure to the benefits of bio-based seed treatments and opportunities to incorporate them into their cultural practices, namely the organic segment of the market.

8:32 AM – 8:42 AM

Tricks and Rewards in Effective Seed Coating of Mycorrhizal Fungi

Fernando Morell*, Reforestation Technologies International

Providing sufficient and healthy food for increasing human population brings the challenge of increasing crop production while diminishing environmental damage. Interest in the use of biologicals to help achieve this by cereal and legume farmers, with large farming operations and sensitive returns, motivated the research to provide a concentrated mycorrhizae fungi inoculant for seed coating. Seed coating effectively guarantees treatment on every seed, decreasing the cost and labor of using biologicals in large scale farming operations. A finished product composed of mycorrhizal fungi propagules from in vivo culture was the first step in ensuring appropriate concentration for seed coating practices. Mykos Gold SC was tested with Sakata Seed America's coating technologies evaluating the effects of the blend in seed germination, seedling development, and root colonization on different crops selected by partners. The use of mycorrhizal fungi seed coating blend did not have adverse effects on seed germination. Initial observations of seedlings reveal slight increase in the measured variables at the time of evaluation. Research revealed it is feasible for mycorrhizae to inoculate a plant through conventional seed coating processes with the appropriate concentration and infectivity of mycorrhizal fungi, in addition to applying coating technologies that are compatible with biology.

8:42 AM – 8:52 AM

Biological Hemp Seed Treatments

Alan Taylor*, Professor at Cornell University

There is renewed interest in industrial hemp as a fiber, grain and medicinal crop plant. In the 2018 US Farm Bill, hemp was exempted as a regulated plant species, allowing biological and chemical pesticides to be used in commercial production. An Integrated Solutions IR-4 project was initiated at Cornell by Professor Alan Taylor (Cornell AgriTech Seed Technology Laboratory) in cooperation with Professor Gary Bergstrom (Plant Pathology and Plant-Microbe Biology, Ithaca) to develop and test selected biopesticide and chemical seed treatments for control of damping-off. The primary soil pathogen responsible for post-emergence damping-off in the Cornell field soils evaluated was *Pythium.* Biological seed treatments including *Trichoderma* and *Bacillus* were provided by four registrants. A phosphite, as well as chemical fungicide seed treatment combinations were also included in the experiments. Lab and field test results will be discussed during the workshop.

8:52 AM – 9:02 AM

Seed Treatment Evaluation Techniques Using Rhizotrons and Root Image Analysis

Shinsuke Agehara*, University of Florida, Gulf Coast Research and Education Center

Our rhizotron system has a 22.9 x 30.5 cm scannable window on each side, which nondestructively quantifies morphological variables of initial root development from seeds or seedlings of various crops. Root images can be obtained using a flat-bed scanner and analyzed by free (ImageJ) or commercial (WinRHIZO Tron) software. Root variables include root number, length, diameter, surface area, and turnover rate, which can be measured using manual or automated techniques. This presentation will discuss experiment protocols to evaluate seed treatments using our rhizotron system.

9:02 AM – 9:30 AM

Panel Discussion

Envisioning a US Citrus Industry with Endemic HLB *CEU Approved*

Coordinator: Manjul Dutt
University of Florida, Lake Alfred, FL, USA
Moderators: Manjul Dutt
University of Florida, Lake Alfred, FL, USA
Catherine Simpson
Texas A&M University, Kingsville Citrus Center, Weslaco, TX, USA

Description:
Citrus is a multibillion-dollar industry and has been commercially farmed since the mid -1800s in the USA. In recent years, Huanglongbing [HLB, caused by the phloem specific Asian Citrus Psyllid vectored *Candidatus* Liberibacter asiaticus (CLas) bacterium] has spread to all the major citrus producing states causing substantial economic losses. HLB results in the development of bitter-tasting and undersized fruit. In advanced stages of infection there is severe defoliation and all trees severely infected with this disease ultimately die. Additionally, none of the major commercial citrus cultivars are resistant to HLB with grapefruits and sweet oranges being very susceptible. All citrus producing counties in Florida (56 percent of the total U.S. citrus crop) currently have HLB. Several parts of Texas and the Riverside area of California have also reported HLB positive trees. The best solution to sustain this industry is to develop strategies that can allow citrus groves to co-exist with endemic HLB by developing tolerant cultivars, managing the tree health and controlling the bacterial development inside the tree.This workshop will discuss the impact of HLB on crop production and productivity and strategies to survive under an endemic HLB environment.

8:00 AM – 8:05 AM

Introduction

Manjul Dutt*, University of Florida

8:05 AM – 8:15 AM

Citrus Huanglongbing: Current Status and Preparing for the Future

Ed Stover*, USDA-ARS

Huanglongbing (HLB) is ubiquitous in FL and severely impacting citrus, is becoming widespread in TX, and has been verified in over a thousand backyard trees in CA. The FL industry has embraced more intensive production practices to sustain production on HLB-affected trees. Growers report that these costly practices permit 'Valencia' production at ~60% of healthy trees, but are less effective on 'Hamlin' (and other early and mid-season processing oranges), and ineffective on grapefruit. So far, the TX industry reports that HLB-affected trees show little deleterious response, with no decline in production. Citrus researchers are immersed in extensive and broad-ranging efforts to identify solutions to HLB. Previous research indicates susceptibility to HLB throughout cultivated citrus: in FL none are immune and many are extremely adversely affected. Small scale trials are producing high yields and quality of susceptible types under protective structures, but this is likely only feasible for very high value fresh fruit. High juice prices, combined with acceptable 'Valencia' production currently sustains FL citrus, but transition to resistant or tolerant planting material is likely critical for maintaining the industry, and would benefit citrus industries wherever HLB threatens. Some rootstocks are reported to confer greater productivity, and new FL plantings emphasize their use. Potentially useful HLB- tolerance is apparent in several mandarin hybrids, including some released cultivars. Work is underway exploring use of HLB-tolerant hybrids to supplement orange juice. HLB-tolerance is reported in some advanced hybrids that include *Poncirus* in their pedigrees, and analyses suggest strong potential for inclusion in the juice stream, as well as for fresh fruit. Biotechnology offers the hope of HLB-tolerance/resistance in cultivars with established high market demand. Numerous transgenic strategies are being tested and show promise, but commercial implementation will require extensive effort and expense to achieve deregulation and replant. Genome editing should provide invaluable solutions, but clear targets to induce HLB-tolerance currently remain obscure. Implementation of effective therapies will be critical, at least in the near-term, to sustain production in existing infected trees. Use of CTV-vectors and transgenics to express anti-bacterial peptides has entered testing on substantial acreage.

8:15 AM – 8:25 AM

The State of Texas Citrus in the Era of HLB

Catherine Simpson*; Veronica Ancona; David Laughlin; Mamoudou Setamou and John da Graca, Texas A&M University, Kingsville Citrus Center

Since the first finding of the Asian citrus psyllid (ACP; *Diaphorina citri* Kuwayama) in 2001 and detection of Huanglongbing (HLB; citrus greening disease) in 2012, Texas has raced to control HLB spread and impact on the citrus industry. A proactive psyllid area-wide management programs have been implemented to reduce ACP populations with significant success. Additional HLB mitigations efforts included the removal of confirmed HLB-positive trees, the production of nursery trees in insect-resistant structures and the phase out of open-field nurseries, and the enactment of quarantines that restrict intra-state movement of plants. Altogether, these strategies have slowed the spread of HLB, but to date the prevalence of HLB is around 40% (2018). Citrus groves in Texas are not yet showing the rate of decline due to HLB that has been recorded in Florida. Some trees that were diagnosed in 2012 are still productive and have maintained yield with minimal dieback, although this is not the case throughout the Lower Rio Grande Valley region. In certain groves there are severe declines in production, distinctive symptomology, and significant dieback, while in others trees exhibit few symptoms and are maintaining if not increasing yield. A historical analysis of Texas citrus acreage and production value per acre we found that not only is citrus acreage increasing but the production value per acre has increased greatly, exceeding Florida production value per acre in 2016. In fact, 2018 Texas citrus production value was 29% of the US total citrus production value compared to California at 36% and Florida at 35%. This shows that while HLB is spreading throughout Texas, the impact is not yet as anticipated, likely because of the control measures put in place and/or the environment. While we are optimistic of our overall outlook regarding HLB, we remain cautious and are invested in proactive measures to control and prevent HLB in new orchards.

8:25 AM – 8:35 AM

How Effective Are Rootstocks in Mitigating the Negative Effects of HLB?

Ute Albrecht*, Southwest Florida Research and Education Center, University of Florida/IFAS

With the endemic presence of huanglongbing (HLB) in Florida interest in the use of rootstocks as a strategy to mitigate the devastating effects of the disease has increased considerably. The importance of rootstock has been recognized since the advent of Phytophthora root rot in the mid-1800s and the occurrence of citrus tristeza virus in the 1940s, which decimated citrus industries around the world. In addition to rendering a tree tolerant or resistant to diseases, rootstock also influences tree vigor, fruit quality, yield, and adaptability to abiotic stresses.

Contrary to most commercial scion cultivars, which are susceptible to HLB, several rootstocks show high levels of tolerance when grown on their own. In a grafted tree, rootstock tolerance usually does not transfer to the scion to a level that reduces HLB incidence and prevents disease development. However, commercial field trials conducted under high HLB pressure demonstrated that productivity of a citrus tree is improved when favoring some rootstock cultivars over others. This has resulted in the high demand for specific cultivars such as ‘US-942’, a hybrid of mandarin (*Citrus reticulata*) and trifoliate orange (*Poncirus trifoliata*), and other newly developed rootstocks for which no seed source trees are yet available.

Traditionally, citrus rootstocks are propagated by seed, which due to the phenomenon of nucellar embryony results in genetically identical plants. In the absence of sufficient numbers of seeds, propagation must occur by alternative methods, namely cuttings or tissue culture. Although tissue culture is widely used for propagation of other tree crops, in Florida there is concern about the increased costs associated with this technology and the potential inferior growth of trees.

In this part of the workshop, results from field trials assessing the performance of a wide range of commercially available and experimental rootstocks, propagated traditionally and by other technologies, are presented. We will discuss the advantage of using rootstock as a management strategy to combat HLB, particularly as it relates to cultivar-specific differences in vigor and productivity, and potential pitfalls arising from alternative propagation methods. In addition, we will discuss the term ‘rootstock tolerance’ and the possible mechanisms associated with this trait.

8:35 AM – 8:45 AM

The Evolving Role of Micronutrient Nutrition As Part of an Integrated Approach to Achieve Profitable and Sustainable Citriculture in an HLB-Endemic Environment

Jude W. Grosser*, University of Florida

Nutritional programs being used in Florida in efforts to

An asterisk (*) in front of a name indicates the presenting author.

maintain productivity from HLB-infected trees were initially focused on foliar nutrient applications. However, we subsequently learned that secondary and micronutrient deficiencies in HLB-compromised trees were twice as great in the roots than in the leaves. Foliar micronutrient applications only temporarily alleviate deficiencies in the leaves, and do not correct deficiencies in the roots. These deficiencies must be corrected in the roots for trees to regain adequate vascular function as necessary to regrow and preserve functional feeder roots. There are several methods available to accomplish this, but we have found soil applications of controlled release fertilizers (CRF) containing enhance micronutrient packages to be quite effective. Fertigation and additional standard dry soluble fertilizer applications have also been successful in various grower programs. Our greenhouse and field data indicates that HLB-impacted trees require a constant supply of the impacted nutrients. Trees under good programs are showing good recovery and productivity, including higher yields of improved quality fruit, and little or no symptomatic fruit. We have also investigated the effects of overdoses of selected micronutrients, and we now have data from multiple experiments showing a therapeutic effect from high manganese. Trees with high leaf manganese content (delivered via the roots) from multiple experiments are showing reduced bacterial (CLas) populations, with qPCR CT values indicating no active infection in many cases. Trees with leaf manganese levels exceeding 60 ppm generally show a strong recovery, and trees exceeding 100 ppm show the therapeutic effect. Data will be presented from two such experiments in commercial groves with no psyllid control, suggesting that focus on root health is much more important than psyllid control, and that growers can go back to more affordable and sustainable IPM programs enhanced for psyllid control.

8:45 AM – 9:00 AM

Predicting Who Will be Living with HLB in the Future

Neil McRoberts*, University of California, Davis

Huanlongbing (HLB) is the most important single threat to sustainable citrus production in the USA and globally. The decline in the Florida industry caused by HLB has been well-documented and the pathogen which causes the disease is now widespread in Texas and is continuing to spread in southern California. In spite of the grim situation apparently facing citrus producers some remain optimistic that citrus production has a viable future in a world with HLB. Based on existing knowledge of disease dynamics and the consequences of HLB infections for citrus production we attempt to predict whether the optimists' beliefs are well-founded and what type(s) of producer might be producing citrus in a world with HLB.

9:00 AM – 9:30 AM

Panel Discussion

Soil Microbiome: Diversity and Function That Contributes to Soil Health and Plant Productivity *CEU Approved*

Coordinators: Susan Miyasaka
University of Hawaii at Manoa, Hilo, HI, USA
Lorenzo Rossi
University of Florida, Fort Pierce, FL, USA
Moderator: Susan Miyasaka
University of Hawaii at Manoa, Hilo, HI, USA

Description:
Below-ground processes have been more difficult to study than above-ground processes, and as a result, have been largely neglected. Microbial communities in the soil impact cycling of nutrients, root growth, soil health, and plant productivity. New, molecular and 3D imaging tools are allowing scientists to better measure, understand, and manipulate interactions between soil microorganisms (both pathogenic and non-pathogenic microbes) and plants. This is a transdisciplinary workshop ranging from soil microbiomes surrounding fruit trees (temperate apples to tropical/subtropical mangoes) to turfgrass. It will encourage sharing of information across disciplines, taking us out of our commodity siloes, and encouraging ideas for future research/collaborations.

8:00 AM – 8:18 AM

Using X-Ray Tomography across Scales to Study Rhizosphere Biology

Keith Duncan*, Donald Danforth Plant Science Center

Understanding root system architecture, and the biotic and abiotic factors that influence its development, is complicated by our current inability to directly observe these processes with genuine fidelity. In an effort to approach biologically relevant non-destructive *in situ* imaging of roots and root development, we have been using X-ray tomography (XRT) to look into the rhizosphere over a range of biological scales. In particular we're interested in the influence of root-microbe interaction on root system architecture in a variety of economically important crop plants over multiple environmental conditions. Our large-scale, high resolution industrial XRT instrument can image complete root systems in a variety of growth media down to 35µm voxel resolution. In addition, we're using an X-ray microscope (XRM) to examine root nodule formation by beneficial nitrogen-fixing bacteria, and root colonization by mycorrhizal fungi, both *in vivo* and with fixed and contrast-enhanced samples. These imaging technologies yield three-dimensional (3D) scan volumes that are rich in data, once the critical biological features are computationally segmented from the scan volumes, currently the greatest challenge in any tomographic imaging strategy. The combination of X-ray imaging and advanced computational analyses is being used to observe, identify, and measure rhizosphere biology in ways not previously practical or possible. In addition, we are exploring the use of Virtual Reality-Augmented Reality (VRAR) as innovative tools for both visualization and segmentation of 3D imaging data.

This work is supported by collaborative agreements with Valent BioSciences, Sumitomo Chemical Company, and the National Science Foundation projects EPSCoR IIA-1355406, PGRP IOS-1638507, and DBI-1759796.

8:18 AM – 8:36 AM

Apple Scion Impacts on Root Exudates and the Rhizosphere Microbiome

Rachel Leisso*, Montana State University

Apples production relies on grafting separate scion and rootstock genotypes together to enable the rootstock to confer productivity characteristics and disease resistance onto the scion. Although the effects of the rootstock on scion health and productivity are reasonably well-understood, the impacts of the scion on the rootstock are relatively unexplored, especially in terms of potential impacts of scion-specific photosynthate quantity and composition. This study assesses the impacts of apple scion cultivars on root exudates and the corresponding rhizosphere microbiome. In a greenhouse experiment, biochemical compounds released by tree roots within the first growing season were shown to differ according to the scion cultivar bud-grafted on the apple rootstock. Cultivar-based differences were more profound in metabolites with potential to inhibit pathogen growth than in metabolites that would promote overall microbial growth in the root-zone. Interestingly, apple scion cultivar did not have a detectable cultivar-based effect on the root-zone microbial community during the first two seasons of growth after bud-grafting, using the same scion and rootstock cultivars. Results additionally indicated that environmental factors, especially temperature and water relations, also impact apple root exudates, both quantitatively and qualitatively. Methodology for plant management, metabolic profiling, rhizosphere microbiome assessment, and data analysis will be discussed. Furthermore, lab resources, experimental design, and sample collection for performing this type of research through "science by mail" will be detailed.

8:36 AM – 8:54 AM

Cover Crops and Biochar Soil Amendments Shift Microbial Communities to Improve Soil Fertility and Fruit Yield in a Southern California Organic Mango Orchard

Michael Pina*, University of California Riverside

Mango (*Mangifera indica*) is major fruit tree crop of the tropics and subtropics, particularly in Asia, where it is among most economically important fruit crops. Mango has very limited production in temperate Mediterranean climates and currently the only US states producing the fruit are California, Florida, and Hawaii. This study focuses on the improvement of organic mango production in the Coachella Valley of Southern California, where the dry/hot desert climate and sandy soil presents a significant challenge for producers. Recent reviews on mango crop management and physiology indicate that the best prospect for improving mango production must involve a holistic approach that considers the specific climate and edaphic environment. The specific goals of this study are to 1) improve soil fertility and 2) increase mango fruit yield. To reach these objectives, a combination of cover crops – including Alfalfa (*Medicago sativa*) and Sudan Grass (*Sorghum* × *drummondi*) – and biochar soil amendments were used to manage nutrient cycling and enhance soil fertility. Biochar is a type of charcoal made from carbon-rich waste products (e.g. wood pellets, tree trimmings, and municipal waste) that can increase organic mango production's water/nutrient use efficiency and yield as well as increase soil populations of beneficial microorganisms. To observe these differences in soil microbial communities, DNA was extracted from the soil, sequenced, and analyzed using QIIME. Results indicate that alfalfa cover crops and biochar work synergistically, shifting towards more beneficial microbial communities to improve soil fertility, mango tree health, and ultimately fruit yield in this Southern California orchard. Mangoes produced in the Coachella Valley fit in to a niche market due to their harvest timing and lack of quarantine restrictions. Therefore, improved organic production in Southern California could add great value to this crop.

8:54 AM – 9:12 AM

Plant Diversity and Land-Use Legacies Alter the Soil Microbiome of Urban Grassland Ecosystems

Grant Thompson*, Iowa State University

Urban grasslands, turfgrass ecosystems kept for recreational or aesthetic purposes, are ubiquitous features of towns and cities across the United States. Though widespread, there remains much to be understood about how establishing urban grasslands and their continual management affects the soil microbiome, and in turn, how other belowground processes may be altered. An overview and the results of two studies will be discussed. Using experimental mesocosms, it was demonstrated that with increasing turfgrass diversity, a corresponding increase in soil microbial diversity was observed. In a subsequent experiment conducted in Baltimore County, MD, residential lawns developed on formerly forested sites showed distinct patterns of soil microbiome compositional shifts relative to reference forest soils, while lawns developed on former agricultural sites showed no discernable effect. The soil microbiome composition was correlated with soil pH and fertility. These insights into controls on the urban soil microbiome suggest both management effects and complex relationships with land-use legacy that alter microbiome composition and may impact microbiome function.

9:12 AM – 9:30 AM

Panel Discussion

Don’t Gamble, Travel with Money - Funding for International Collaboration *CEU Approved*

Coordinator: Roland Ebel
Montana State University, Bozeman, MT, USA
Moderator: Rhuanito Ferrarezi
University of Georgia, Athens, GA, USA

Description:
This workshop provides information about international grant and funding opportunities. It orientates academics (students up to emeritus faculty) about the options available for international collaboration in horticultural studies, as well as how to obtain funding. Since teaching and research have become more complex during the last decades, they also became more international. Technical progress has facilitated this process and the benefits are numerous: Cooperation with universities from overseas often creates synergies between research, teaching, and extension. It provides access to further expertise and foments critical reflection due to different points of view. In many fields, cooperation is not only a requirement but a need, for example in the research about global public goods such as water or the atmosphere. For researchers, it can boost the number of publications as many peer-reviewed journals privilege articles from international author teams. Internationalization helps reducing research costs thanks to avoidance of duplicated effort, the possibility of sharing infrastructure, and access to well-funded finance opportunities limited to international proposals. For institutions, collaboration can improve their reputation and attract more students, and for research groups in developing countries, internationalization can be an essential step towards professionalism. Finally, working with different cultures stimulates the development of respectful relationships and diverse networks, and it even can improve language skills. Consequently, the goal of this workshop is to enhance international collaboration and motivate students and faculty interested in going abroad. It includes both, general information and practical advice. Therefore, the workshop will be developed in three stages: (1) a general introduction to grants and funding for International collaboration, (2) presentations emphasizing different World regions, and (3) information desks for personalized advice, where academics can contact an expert for the region of their choice.

10:15 AM – 10:35 AM

Grants and Funding for International Collaboration for Students up to Senior and Emeritus Faculty

Louise Ferguson*, University of California, Davis
As communication technologies shrink the world the demand for horticultural expertise in teaching, basic and applied research and extension increases. However, finding an appropriate project among the hundreds of annual requests, and navigating the proposal preparation, project execution and reporting germane to each funding body is confusing. This session will explain some of the approaches to becoming a successful international consultant.

10:35 AM – 10:55 AM

Opportunities for International Collaborations in Africa and Asia

Elizabeth Mitcham*, University of California, Davis
Horticulture faculty and students who want to establish collaborations in Africa or Asia should first investigate programs at their home institution. Many universities have agreements with organizations outside of the United States, such as research institutes or universities, for research or teaching collaborations. In addition, there may be existing grant programs at your university that may include opportunities for students or faculty to assist.

The Horticulture Innovation Lab has a “Find a Collaborator” page on its website (http://horticulture.ucdavis.edu/find-collaborator) where you can look for individuals in your country of interest who are interested in collaborations. You can also post your information and indicate the types of collaborations you are interested in and your area of expertise. You should also consider signing up for newsletters from a range of potential funding agencies, including the Horticulture Innovation Lab to stay abreast of funding opportunities.

One of the best opportunities for faculty is the U.S. Fulbright Scholars Program. Fulbright offers nearly 470 teaching, research or combination teaching/research awards in over 125 countries. Opportunities are available for college and university faculty and administrators as well as for various professionals, independent scholars and many others. In addition to several new program models designed to meet the changing needs of U.S. academics and professionals, Fulbright is offering more opportunities for flexible, multi-country grants. In addition, there are numerous opportunities for both volunteer and paid consulting positions to provide short term technical assistance in many countries around the world. Participation in a Fulbright Scholar Program or a short term technical assistance program can open a range of opportunities for future collaborations by cementing relationships with scientists, faculty and students in other countries. Once a relationship is developed and familiarity established, joint grant proposals can be pursued along with other opportunities.

Students should consider study-abroad opportunities as well as consult with their international programs office to learn about other opportunities. Post-degree, the Peace Corps is a great opportunity to learn more about other countries and international work. Many CG centers offer opportunities for students to conduct research on site which provides an opportunity to establish important linkages for collaboration as well as research mentoring. An overview of these opportunities will be discussed during this session.

10:55 AM – 11:10 AM

South America Collaboration Opportunities

Rhuanito S. Ferrarezi*, University of Florida

Partnerships between Latin and North American higher education institutions are a common strategy to foster mutually beneficial collaboration and promote international, multidisciplinary, and transcultural research, teaching, and service activities. With a vibrant and diverse culture, Latin American countries can send or host foreign scholars for up to twelve months. The goal of this interactive conversation is to work towards presenting international exchange programs to faculty, postdocs and students to develop and sustain collaboration opportunities. These programs can enable researchers to obtain international experience. Dr. Ferrarezi will lead a review and discussion of opportunities and challenges in South America, emphasizing Brazil. Come learn about the types of potential scholarships available and the eligibility requirements!

11:10 AM – 11:20 AM

Collaboration with Mexican Universities

Roland Ebel*, Montana State University

While most international students come from Asian countries, Mexico is among the leaders in academic cooperation with American universities, especially in the field of horticulture. Cooperation refers to both, faculty mobility and joint research. However, the output, for example in terms of scientific papers coauthored by U.S. and Mexican researchers, is disappointingly low. This circumstance cannot be attributed to a lack of funding opportunities, since these exist abundantly at governmental and university level; and a considerable number of these grants is particularly dedicated to agri- and horticultural sciences. To make use of these funds and to increase their efficiency, I will present potential contacts for partnerships (or less formal cooperation) between US and Mexican universities, as well as programs for academic mobility across the border.

11:20 AM – 11:45 AM

Find Your Funding Opportunity!

Rhuanito S. Ferrarezi*[1]; Elizabeth Mitcham[2]; Roland Ebel[3] and Louise Ferguson[2], (1)University of Florida, (2)University of California, Davis, (3)Montana State University

After the initial presentations about funding for collaborations with institutions in different regions of the world, the audience will have the opportunity to contact our experts personally. Therefore, the meeting room will be divided into three areas or information desks: one desk, headed by Dr. Ferguson, deals with funding questions in general; a second desk, coordinated by Dr. Mitcham, emphasizes international horticultural cooperation with African and Asian institutions; and a third information desk with Dr. Ferrarezi and Dr. Ebel provides information about opportunities in Latin America. Our experts answer concrete questions about funding and grants for students and faculty. Their advice includes information sources, contact persons, sponsors, but also about strategically skilled behavior for applicants. This information is helpful for academics interested in international research projects, research networks, student exchange, sabbatical stays, as well as for hosting foreign faculty.

Keynote Speaker: Dr. Larry Smart

From Grey Area to Gold Rush: Establishing a Comprehensive Hemp Research Program *(Poster Board #)*

Lawrence B Smart*, Cornell University

Although hemp (*Cannabis sativa*) was widely grown in the US during the 1940’s to support the war effort, this was an exception to its illegal status as a crop established in the 1930’s. The 2014 and 2018 farm bills have progressively legalized hemp cultivation, sparking tremendous interest in hemp farming and processing. While there is an established, but small, market for hemp food and fiber based products in the US that is largely supplied by hemp from China and Canada, the market for cannabidiol (CBD) is exploding. Peer-reviewed agronomic data on hemp are scarce, since there has been minimal public funding for academic research, but with legalization of hemp, that is expected to change. Cornell University has assembled a multidisciplinary team of researchers and extension educators who are building a program to study hemp cultivation, pests and diseases, microbiome, agroecology, biochemistry, tissue culture and transformation, production economics, and to establish a long-term breeding program to produce new cultivars. This talk will provide an update on key advances and barriers we have encountered in the process of normalizing academic research on hemp.

Dr. Larry Smart is a Professor in the Horticulture Section of the School of Integrative Plant Science at Cornell University and is Associate Director of Cornell AgriTech in Geneva, NY. Larry is a plant geneticist and breeder whose lab uses genomic tools in breeding shrub willow bioenergy crops and to better understand hybrid vigor and pest and disease resistance. More recently, he has been leading Cornell’s hemp research and extension team and has initiated a long-term breeding program to develop new hemp cultivars for New York State. He received his B.S. in Biology at Cornell University, Ph.D. in Genetics at Michigan State University, and was an NSF Postdoctoral Fellow at UC-Davis

Exhibitor Talks 1: New Innovations in Horticulture Technologies and Products - *CEU Approved*

Description:

To introduce conference participants to new and innovative technologies available for research, teaching, and extension.

An asterisk (*) in front of a name indicates the presenting author.

12:30 PM – 12:45 PM

The Importance and Role of ARM Software in the Industry

Kyle D. Kepner*, Gylling Data Management Inc.

With over 10,000 researchers and scientists worldwide depending on ARM, find out how understanding ARM software can help you with a future career in the industry.

12:45 PM – 1:00 PM

Meet Hobonet™ Onset's Wireless Field Monitoring System

Matt Sharp*, Onset Computer Corporation

1:00 PM – 1:15 PM

Agro Research International

Marc Lajeunesse*, Agro Research International

Medicinal Plants As Cash Crops: Growing and Processing for Quality Products. *CEU Approved*

Coordinator: Changbin Chen
University of Minnesota, St. Paul, MN, USA
Moderator: Katherine Warpeha
University of Illinois at Chicago, Chicago, IL, USA

Description:
Our goal is to provide information and opportunities for discussions regarding recent development of medicinal plants as high-value horticultural crops and make connections among extension professionals, growers, biochemists, and students who are interested in Herbs, Spices, and Medicinal Plants as specialty crops.

2:00 PM – 2:05 PM

Introductory Remarks-K. Warpeha

2:05 PM – 2:20 PM

Hop Variety Trials Under Extended Day Length in Central Florida

Zhanao Deng*, University of Florida

2:20 PM – 2:35 PM

Traditional Brassica Cruciferous Vegetables: Optimized Protocols for Indoor Farming of High Value Products

Katherine Warpeha*, University of Illinois at Chicago

2:35 PM – 2:50 PM

Growing Codonopsis for Functional Food, an Industry View

Xiaozhong Liu*, Amway Corporation

2:50 PM – 3:05 PM

Black Goji Berry As a Special Crop for Agricultural Buffer Strip in Minnesota

Changbin Chen*, University of Minnesota

3:05 PM – 3:30 PM

Discussions -K Warpeha

Reducing Food Losses: an Interactive, High-Stakes Game Approach *CEU Approved*

Coordinator: Steven Sargent
University of Florida, Gainesville, FL, USA
Moderators: Steven Sargent
University of Florida, Gainesville, FL, USA
Sastry S. Jayanty
Colorado State University, Center, CO, USA
Peter Petracek
Valent BioSciences Corp, Libertyville, IL, United States

Description:
The objective of this workshop is to develop a better understanding of the challenges faced by the fresh produce industry to reduce losses from harvest through consumer levels by audience participation in an interactive game.

Experts will present brief overviews on the challenges faced by the industry at five critical levels in the produce value chain: farmer, packer/shipper, distribution center, alternative markets, and consumer levels. The audience will then self-divide into one of the Commodity Teams, then choose a Distribution Point for participation during the 30-minute game.

Sales and/or purchase goals will be assigned to participants at each Distribution Point, along with resources to market and/or purchase their commodity. The game will begin with buying and selling at each level. But, the teams must watch out for the random Challenge Card that could bring chaos to their plans! The Commodity Team that most effectively utilizes their resources from farm through consumer levels while minimizing losses will be declared the winner. The workshop will end with the teams sharing lessons learned with the entire group.

2:00 PM – 2:15 PM

Challenges Faced at the Farmer Level

Lisa K Johnson*, North Carolina State University

2:15 PM – 2:30 PM

Challenges Faced at the Packer/Shipper Level

Hemant Gohil*, Cooperative Extension of Rutgers University

2:30 PM – 2:45 PM

Challenges Faced at the Distribution Center Level

Jeffrey K. Brecht*, University of Florida

2:45 PM – 3:00 PM

Challenges Faced at the Alternative Markets Level

Elizabeth Mitcham*, University of California, Davis

3:00 PM – 3:15 PM

Challenges Faced at the Consumer Level

Eleni D. Pliakoni*, Kansas State University

Reaching New Audiences in the "Plant Parent" Generation *CEU Approved*

Coordinators: Natalie Bumgarner
University of Tennessee, Knoxville, TN, USA
Esther E. McGinnis
North Dakota State University, Fargo, ND, USA
Sarada Krishnan
Denver Botanic Gardens, Denver, CO, United States

Moderators: Natalie Bumgarner
University of Tennessee, Knoxville, TN, USA
Casey Sclar
American Public Gardens Association, Kennett Square, PA, USA

Description:

Objectives: This workshop is designed to inspire greater investments in connection with younger audiences and equip horticulture educators, researchers, and public garden professionals with the language and a more diverse toolkit to reach this new generation of 'plant parents' aka gardeners.

Description: As horticulturists, educators, and researchers, we are in danger of not connecting with a younger generation that is very interested in our topic but may have differing perspectives and vocabulary. This workshop is designed to focus on opportunities and techniques for addressing challenges in connecting younger audiences with horticulture. The workshop will begin with an interactive discussion about current ways younger generations (primarily generation Y and younger) are connecting with plants and how that contrasts with previous generations. This opening discussion will focus on how many of our efforts are framed by the use of traditional terms, such as "gardening" and "horticulture" that may be counterproductive in reaching younger audiences. This terminology discussion will lay the foundation for three presentations focused on connecting with a younger audience interested in integrating plants in their lives. Three avenues of connection will be explored by experts in retail and marketing, digital outreach and social media, and public gardens outreach. The remaining portion of the workshop will be concentrated on a facilitated discussion where attendees will focus on application and next steps. Building on the ideas presented in the talks, attendees will further identify current shortcomings in reaching new audiences and will develop feasible solutions that could be used in current teaching, research, Extension, and public horticulture programs or new efforts to bridge this gap. Attendee contributions will be captured on flip charts and content will be related to current consumer horticulture and public gardens collaborations underway including the National Initiative for Consumer Horticulture.

4:15 PM – 4:30 PM

Introductory Remarks

4:30 PM – 4:45 PM

Promotions Influence on Young Consumers in the Garden Center

Alicia Rihn*, University of Florida

In the ornamental horticulture industry, young consumers are becoming an important market segment due to first-time home ownership and increasing spending power. However, due to diverse life experiences and other factors, these age groups likely view ornamental plants and their promotions differently. During this presentation, similarities and differences in consumer perceptions and reactions to retail promotions for ornamental plants between age groups will be discussed. A special emphasis will be placed on point-of-sale information and how attention to that information impacts consumer behavior in the retail environment.

4:45 PM – 5:00 PM

What Millennial Plant Parents Want in Their Media

Jourdan Cole*, Garden Media Group

The millennial demographic engages with content an average of 18 hours per day and in new ways, creating more touchpoints to communicate with this generation than before. Constantly connected, they want information, and they want it fast, in short, crisp, visually appealing and moving posts. This presentation will be led by a digital marketer and average millennial. It will define what plant-loving millennials value and the best ways to reach this demographic digitally.

5:00 PM – 5:15 PM

The Plant Heroes Saved Our Plant Parents from Being Eaten By Couch Potatoes While Your Crop Wild Relatives Watched

Casey Sclar*, American Public Gardens Association

With an estimated 120 million visitors per year, public gardens offer a wide variety of experiences for diverse audiences of all ages. Nature prescriptions, gene conservation, pollinators, the integration of music, food, and the ability to celebrate cultural history…combined with an opportunity to meet new peers, promote citizen science, pursue a new career…or just relax, disconnect, and cosplay (or be yourself). Several different case studies, programs and initiatives will spotlight all the connection points possible. Special emphasis will be placed on future careers, initiatives, and potential cross-collaborative research products to help consumer horticulture grow.

5:15 PM – 5:45 PM

Discussion

Wednesday, July 24, 2019

Fruit and Nut Germplasm Collections: Treasuries of Genetic Diversity *CEU Approved*

Coordinators: Ksenija Gasic
Clemson University, Clemson, SC, USA
Nahla Bassil
USDA-ARS NCGR, Corvallis, OR, USA
Moderator: Ksenija Gasic
Clemson University, Clemson, SC, USA

Description:

The goal of the workshop is to showcase the diversity preserved within Fruit and Nut germplasm collections in the NPGS. To emphasize their importance and expose critical needs and vulnerabilities. Discussion session will serve to engage the members in potential solutions for advocating for the visibility and importance of these living treasuries to the research, breeding, and general stakeholders.

8:00 AM – 8:05 AM

Welcoming Remarks

8:05 AM – 8:25 AM

National Clonal Germplasm Repository – Tree Fruit & Nut Crops & Grapes, Davis, California

John E Preece*, National Clonal Germplasm Repository USDA-ARS

The National Clonal Germplasm Repository Davis, CA (NCGR) curates the national collections of the following 14 Mediterranean fruit and nut crops: almond, apricot, cherry, fig, grape, kiwifruit, mulberry, olive, peach, persimmon, pistachio, plum, pomegranate, and walnut. The overarching goal is to preserve these genetics for current and future generations. The challenge is that these crops do not breed true and must therefore be maintained as plants in the field, making preservation of clonal crops considerably more expensive than annual crops that can be stored as seeds. The mission is to acquire additional genetics to fill gaps in the collections, maintain the plants in the collections, freely distribute the genetics (typically as dormant scionwood) to scientists worldwide, and to evaluate the collections and make those data available online on the Germplasm Resources Information Network (GRIN-Global). Because of freely distributing the germplasm, there is nothing modern and under patent or proprietary protection in the collections. Rather, they consist of older cultivars, breeder lines, and the genetically richest portion of the collections, the crop wild relatives. All are available for scientific study. Challenges with managing an expanding collection will be discussed.

8:25 AM – 8:45 AM

Plant Genetic Resources Unit, USDA-ARS, Apple, Grape, and Tart Cherry Germplasm Collection, Cornell Agritech, Geneva, New York

Chihcheng T. Chao; Benjamin Gutierrez* and Gan-Yuan Zhong, USDA-ARS Plant Genetic Resources Unit

The USDA-ARS Plant Genetic Resources Unit (PGRU) at Cornell AgriTech, Geneva, NY is the home of the apple, cold-hardy grape and tart cherry germplasm collections of the National Plant Germplasm System (NPGS). PGRU maintains 7,101 *Malus*, 1,405 *Vitis* and 130 *Prunus* accessions and provides curatorial service for the maintenance, acquisition, distribution, characterization, and research of these critical genetic resources. We use conventional field planting, seed storage, and cryo-preservation of budwood and pollen to maintain and ensure the long-term safety of the collections. For acquisition, we import rare varieties, such as cider apples from Northern Spain and England, carry out domestic and international explorations of crop wild relatives, and select permanent accessions through genetic analysis and trait evaluation of seedlings of wild species. In 2018, PGRU distributed 8,197 samples, including cuttings/scions, pollen, flowers, leaves, DNA, fruit, and seed based on a record 540 requests. PGRU records descriptors and images for each accession, evaluates fruit quality and tolerance to biotic and abiotic stresses, adopts new phenotyping methods, and establishes genetic markers to study diversity, relationships among accessions and map traits of interest. All accession information is added to the GRIN-Global database. PGRU also cooperates and supports many domestic and international research and breeding efforts of apple, grape and tart cherry.

8:45 AM – 9:05 AM

Dynamic Use of the National Collection of Genetic Resources for Pecans and Hickories

Larry J Grauke*, USDA

Our unit was initially designated as a National Clonal Germplasm Repository based on an existing collection of grafted cultivars developed for use as parents by the USDA ARS Pecan Breeding Program. From its inception, the NCGR-*Carya* has pursued a dynamic collection strategy with three distinct targets: 1) collection of named cultivars from culturally distinctive growing regions to represent selections made over the 170+ year history of grafting pecans; 2) provenance collections of self-rooted seedlings to represent genetic diversity in the context of geographic origin; 3) representative collections of *Carya* species to provide the broadest base of potentially compatible genetic diversity. The entire collection currently is maintained as living inventories at two worksites in Texas, where 5 ARS workers maintain trees on 242 hectares. Graftwood distributions have historically been requested from only a small subset of accessions, primarily the most recently released cultivars, while seed distributions have been from a small subset of primarily standard seedstock sources. Graftwood exchange is impacted by the presence of disease caused by the bacterial pathogen *Xylella fastidiosa*. The broad genetic diversity available in the collection is being used by multiple international teams for developing improved methods of molecular characterization based on genome sequencing. Inventory specific records of NCGR-*Carya* provide the "type" collections for genomic profiles of taxonomic species and are a particularly valuable laboratory for studying interspecific hybridization. Phenotypic records linked to pecan provenance inventories in replicated test configurations provide evidence of regional adaptation related to genetic diversity that varies between geographic subpopulations. Historically documented passport records of regional pecan cultivars linked to their phenotypic and genomic characterizations provide the foundation for identity verification procedures and tools for development of marker assisted selection. This accessible, diverse, living collection of trees is contributing to the development of the next generation of *Carya* scientists, as they work toward the refinement of improved genomic techniques. The next generation of breeders will use these tools to select cultivars with traits targeted for improved regional performance from broad foundations of genetic diversity available within the collection. Long-lived test systems on NCGR-*Carya* worksites will provide foundations for future development of improved techniques such as remote imaging. As this generation of breeders works cooperatively within these diverse collections, we hope to facilitate continued coordinated use. Cryopreservation of pollen from selected inventories is being pursued in conjunction with scientists at the USDA National Center for Genetic Resources Preservation, Fort Collins, CO.

9:05 AM – 9:25 AM

Guardians of the Germplasm: Berries, Pears, Hazelnuts, Hops, and Mint

Kim E Hummer*, USDA ARS and Joseph Postman, USDA-ARS-NCGR

The NCGR-Corvallis is one of about 30 federal facilities in the U.S. National Plant Germplasm System dedicated to preserving economically important crops and their wild relatives. This genebank opened in May 1981, through a congressional funding mandate of the U.S. Department of Agriculture to conserve hazelnuts, strawberries, hops, mint, pears, currants/gooseberries, raspberries/blackberries, blueberries/cranberries, and other related crops. The objectives of the unit are to collect, maintain, distribute, and evaluate genetic resources for these crops. The collection now includes more than 12,000 accessions. About half are seedlots and half are living plants. Clonal collections are conserved in 35 acres of field plantings, and as potted plants in about 30,000 square feet of screen/greenhouses. Seeds are stored in freezers at -20^{o}C. These living plant collections are some of the most extensive in the world for each genus, and represent diverse wild species as well as heritage cultivars. Since 1981, the NCGR has annually distributed between 6,000 and 10,000 samples (cuttings, plants or seeds) to plant breeders and researchers around the world. The NCGR staff collaborates with international scientists on better characterizing these valuable resources. Important service activities and research findings include:

- Maintenance of >12,000 diverse living plant and seed accessions for global horticultural research.
- Development of molecular markers for horticultural/botanical identity and diversity.
- Evaluation of flowering, fruiting, and plant characteristics for each accession.
- Evaluation of disease and pest resistance of strawberries, raspberries, pears, quince, hops, and hazelnuts.
- Description of new species and reports on species range extensions.
- Improvement of culture media for in vitro growth and medium-term cold storage of fruits and nut plants.
- Development of protocols for cryopreservation of dormant buds for long-term conservation.
- Determination of the phylogeny, biogeography, and taxonomy of assigned fruit, nut, and specialty crops.

Base funds have been unchanged for the past decade, though administrative costs and collections have expanded. New diseases and pests increasingly threaten each crop. Despite these challenges, the Corvallis genebank provides reference living plant materials for hundreds of international scientists and plant breeders each year. NCGR continues to guard the integrity of horticultural germplasm for future generations

9:25 AM – 9:55 AM

Discussion

Cannabis in Canada: Year 1 - Highs and Lows

Description:
Success and Missteps....

Update on the Cannabis Industry in Canada
(Poster Board #)

Jeffrey Norrie*, Breathing Green Solutions

Keynote Address: Dr. Harry Klee

Making Tomatoes Great Again: Leveraging Bio-

chemical Genetics to Give Consumers What They Really Want *(Poster Board #)*

Harry J. Klee*, University of Florida

Harry Klee received a PhD in Biochemistry from the University of Massachusetts. He did postdoctoral research at the University of Washington where he studied the mechanisms of Agrobacterium crown gall formation. He then worked at Monsanto from 1984-1995 where he worked on development of herbicide resistant crops. There he initiated work to use transgenic plants to understand the biology of phytohormones. In 1995, he took an endowed chair at the University of Florida where, in addition to his ethylene research, he established a program to understand the biochemistry and genetics underlying flavor of fruit crops. Working in collaboration with sensory and food scientists, his laboratory has identified the chemicals that define good tomato flavor. He has used large-scale genomics approaches to understand why modern commercial tomatoes have lost good flavor and to develop a genetic roadmap for recovering heirloom flavor. Dr. Klee was elected as a AAAS Fellow in 2009 and to the National Academy of Sciences in 2012.

Application of CRISPR-Mediated Genome Engineering for Breeding Horticultural Crops for Disease Resistance and Quality Traits: Progress, Challenges and Future Prospects *CEU Approved*

Coordinators: Krishna Bhattarai
Gulf Coast Research and Education Center, University of Florida, Wimauma, FL, USA
Sanjun Gu
North Carolina Agricultural and Technical State University, Greensboro, NC, USA
Moderators: Heqiang Huo
University of Florida, Apopka, FL, USA
Krishna Bhattarai
Gulf Coast Research and Education Center, University of Florida, Wimauma, FL, USA

Description:
Objectives:

1. To obtain current knowledge and tools available for improving horticulture crops using CRISPR-mediated genome editing

2. To overview recent advances in CRISPR-mediated genome editing in horticultural crops breeding via case studies

3. To determine the biotechnological challenges and limitations in using genome editing in cultivar development

4. To discuss future deployment of genome editing technology in increasing disease resistance and horticultural qualities

5. To discuss current rules and regulations and future perspectives on using CRISPR-genome editing in developing new cultivars

Description:

This workshop will be primarily focused on the use of CRISPR genome editing in horticultural crops. It will cover the prospective, challenges, opportunities and current status and future of using this technology in diverse set of horticultural crops. There will be talks ranging from technological development (protocol development) to status and future sighting of regulatory measures that will determine the application of this technology in horticultural industry in coming days. There is an excellent list of speakers ranging from specialties in diploid to polyploid crops, homozygous to highly heterozygous and outcrossing species, from annuals to perennials and USDA Biotechnology Regulatory Services. With recent developments in this technology, there will be information on CRISPR-genome editing for wide range of horticultural crops including regulatory aspects of the technology.

At the end of the workshop, there will be a 15-minute panel discussion which will address questions from the audience and provide networking opportunities between speakers and audience. The discussion will highlight on how can this technology be applied in wide range of horticultural crops with limited genomic information and how can new cultivars be developed and available for commercial production using CRISPR-genome editing.

2:00 PM – 2:02 PM
Introductory Remarks

2:02 PM – 2:15 PM
Lipofection-Mediated DNA-Free Delivery of the Cas9/gRNA Ribonucleoprotein into Plant Cells for Genome Editing

Wusheng Liu*[1]; Neal Stewart Jr.[2]; Mary Rudis[2]; Mathew Cheplick[2]; Reginald Millwood[2]; Christine Ondzighi-Assoume[3]; Mitra Mazarei[2]; Kellie Burris[2]; Jonathan Chesnut[4] and Jian-Ping Yang[4], (1)North Carolina State University, (2)University of Tennessee, Knoxville, (3)Tennessee State University, (4)Thermo Fisher Scientific

Genome editing enables precise manipulation of specific genomic sites with the newly developed CRISPR (clustered regularly interspaced short palindromic repeats)-Cas9 system being the most promising genome editing tool. DNA-based delivery of the CRISPR-Cas9 system has been routinely used in various plant species. However, protein delivery of the *in vitro*-translated Cas9/gRNA ribonucleoprotein (RNP) complex into plant cells is still in its infancy even though protein delivery has advantages such as ease of use, low cost, relative ease to be adapted to high throughput systems, and lower off-target cleavage rates. The present study is the first time to successfully develope lipofection-mediated transfection as a novel approach for protein delivery of the preassembled Cas9/gRNA RNP complex into plant cells for genome editing. This approach was achieved using Lipofectamine 3000- or RNAiMAX-mediated transfection. Using either method, we demonstrated that the pre-complexed Cas9/gRNA RNP complex in which a GFP was tagged in-frame to the 3'-end of the Cas9 protein was successfully delivered into non-transgenic tobacco cv. Bright Yellow-2 (BY-2) protoplasts. The optimal lipofectamine 3000- and RNAiMAX-mediated protein delivery efficiencies were 66 and 48%, respectively. We also developed a new biolistics approach based on the published proteolistics method. When delivered into transgenic BY-2 protoplasts or cells with 60% cells overexpressing an orange fluorescent protein (OFP) reporter gene *pporRFP* with each gRNA targeting the *pporRFP* gene, we demonstrated that Lipofectamine 3000-mediated protein delivery had higher targeted mutagenesis frequency than the PEG-mediated DNA delivery method and the biolistics-mediated protein delivery method. Thus, the newly developed lipofection approach is sufficiently robust for the use of the DNA-free Cas9/gRNA RNP technology for genome editing in plant cells.

Specified Source(s) of Funding: Advance Research Projects Agency - Energy; NCSU startup funds

2:15 PM – 2:30 PM

Practical Applications of CRISPR Gene-Editing for Tomato Improvement

Tong Geon Lee*, University of Florida

Tomato (*Solanum lycopersicum*) yield has increased steadily throughout the years due to increase in genetic potential and advances in horticultural practices. Nonetheless, further improvement in horticultural performance is still necessary, especially given rising production costs. One of the major changes in the horticultural industries in the U.S. is a shift toward lower labor inputs and increased mechanization to achieve higher levels of productivity with lower costs. To accomplish this in the U.S. field-grown, fresh-market tomato, it is imperative to incorporate genes that optimize phenotypes that make such mechanization feasible. Scientists at the University of Florida and their colleagues are now using CRISPR to alter genes thought to influence tomato's architecture. In this talk, recent studies of genetic loci that have been shown to be key components for achieving beneficial phenotypes will be discussed.

2:30 PM – 2:45 PM

Citrus Improvement Via the CRISPR Technology

Nian Wang*, University of Florida

Citrus is one of the most important fruit crops worldwide. New cultivars are needed to meet the need to overcome many biotic and abiotic threats as well as to improve the horticultural traits to create new marketing opportunities. However, the traditional approach of citrus breeding is difficult due to the long juvenility, large tree size, and prevalence of polyembryonic seeds in commercial varieties. Clustered regulatory interspaced short palindromic repeat (CRISPR) technology has been widely employed to edit genome in many organisms including citrus. Here I will overview the scientific and technological progress as well as challenges in citrus genome editing via CRISPR technology. The application of different CRISPR tools on citrus genome editing will be presented. Generating non-transgenic citrus varieties via CRISPR technology will also be discussed.

2:45 PM – 3:00 PM

Improving the Strawberry Fruit Quality and Disease Resistance Using Genetic Engineering Technologies: Current Progress and Challenges.

Seonghee Lee*; Cheolmin Yoo; Jin-Hee Kim; Youngjae Oh; Heqiang Huo and Vance M Whitaker, University of Florida

The University of Florida (UF) strawberry breeding program has recently been employing advanced biotechnology and genetic engineering technologies for new cultivar development. Using genetic engineering methods such as CRISPR-based gene editing and somaclonal variation, we are able to enhance new superior cultivar development for fruit quality and disease resistance. Due to the complexities of deregulation and persistent social barriers to genetically engineered, this new type of non-GMO technology has much greater potential than traditional GMO technologies for developing new and superior strawberry cultivars. We anticipate that gene-editing and somaclonal variation can be used to bring strawberries to the growers and industry with improvements in yield, disease resistance, shelf life, nutrition and other valuable attributes. To utilize the CRISPR gene-editing technology for octoploid strawberry, we first developed and optimized tissue culture and transformation system for the main UF breeding varieties such as Sweet Sensation, Florida Beauty and Florida Brilliance. Somaclonal variation (SV) is effective tool to improve diseae resistance and fruit quality in cultivated strawberry. Strawberry varieties developed by SV do not regulated as GM crop especially in Euroupe. We are currently developing clonal variants of important commercial strawberry varieties for disease resistance combining with superior fruit quality.
In this presentation, we will discuss about recent advances in genetic engineering to improve fruit quality and disease resistance, and future perspectives for genetic engineered strawberry fruits.

3:00 PM – 3:15 PM

USDA Approach to Regulating Biotechnology

Neil E. Hoffman*, United States Department of Agriculture

The Federal government has a coordinated, risk-based system to ensure that new biotechnology products are safe for the environment and human and animal health. Established as a formal policy in 1986, the Coordinated Framework for Regulation of Biotechnology describes the Federal system for evaluating products developed using modern biotechnology. The Coordinated Framework is based upon existing laws designed to protect public health and the environment. The U.S. government has written regulations, policies, and guidance to apply these laws to biotechnology-derived products.

The U.S. Government agencies responsible for oversight of the products of agricultural modern biotechnology are the USDA's Animal and Plant Health Inspection Service (USDA-APHIS), the U.S. Environmental Protection Agency (EPA), and the Department of Health and Human Services' Food and Drug Administration (FDA). Depending on its characteristics, a product may be subject to the jurisdiction of one or more of these agencies. Regulatory officials from the three agencies regularly communicate and exchange information to ensure that any safety or regulatory issues that may arise are appropriately resolved.

USDA first issued biotech regulations based on its statutory authority in 1986 and has only made modest revisions since. Major revisions were proposed in 2008 and 2017, however APHIS withdrew both rules in response to public comments and to reengage in a fresh dialogue with stakeholders on the regulation of biotechnology. Work is underway for a third proposed rule that optimistically will be published sometime in 2019.

3:15 PM – 3:30 PM
Panel Discussion

Mitigating Impacts of Climate Change in Urban Landscapes *CEU Approved*

Coordinators: Janet S. Hartin
University of California Cooperative Extension, Davis, CA, USA
Lloyd L. Nackley
Oregon State University, Aurora, OR, USA
Igor Lacan
University of California Cooperative Extension, Davis,, CA, USA
Moderator: Lloyd L. Nackley
Oregon State University, Aurora, OR, USA

Description:
The workshop goal is to provide an overview of the current status of applied research related to mitigating the impacts of climate change on urban landscapes and to discuss and prioritize needs for additional research by participants. Interest in proposing a new Professional Interest Group in this area will also be discussed.

2:00 PM – 2:15 PM
Introductory Remarks

2:15 PM – 2:30 PM
Reducing Landscape Water Loss in Urban Plantings
Janet S. Hartin*, University of California Cooperative Extension

2:30 PM – 2:45 PM
Mitigating Temperature and Drought Stress in Production Systems
Lloyd L. Nackley*, Oregon State University

2:45 PM – 3:00 PM
Identifying Climate-Ready Trees in California Cities Using Space-for-Time Substitution
Igor Lacan*, University of California Cooperative Extension

3:00 PM – 3:15 PM
Emerging Pest and Pathogen Pressures Related to Changing Climates
Drew Zwart*, R.A. Bartlett Tree Research Labs

3:15 PM – 3:30 PM
Panel Discussion

Exhibitor Talks 2: New Innovations in Horticulture Technologies and Products *CEU Approved*

Description:
To introduce conference participants to new and innovative technologies available for research, teaching, and extension.

2:00 PM – 2:20 PM
The National Association of Plant Breeders: Supporting the Sustainability of Plant Breeding to Insure Future Innovations
Peggy Ozias-Akins*, University of Georgia

2:20 PM – 2:40 PM
Recent Advancements in Photosynthesis Systems, Spectrometers, and CO2 Analyzers
Eric Price*, LI-COR Biosciences

2:40 PM – 3:00 PM
Latest Innovations in Sensors from Apogee Instruments
John Huber*, Apogee Instruments
Apogee Instruments develops and manufactures innovative environmental instrumentation for horticulture, meteorology, sustainable food production, and renewable research applications. The Logan, UT based company was founded in 1996 by Dr. Bruce Bugbee, a professor of crop physiology at Utah State University, with the focus of providing high-quality, cost effective instrumentation for research and commercial applications. This year at ASHS, Apogee will be featuring developments for our Bluetooth µCache, two band

radiometers for NDVI, PRI, Red/Far Red, and PAR/Far Red measurements, and new coefficients for our MC-100 chlorophyll concentration meter including grapevine and cannabis.

3:00 PM – 3:20 PM

New Innovations from Ag Biotech, Inc.

Tristan Hudak*, Ag BioTech

B.Y. Morrison Memorial Lecture: Dr. Mary Meyer

Moderator: Chavonda Jacobs Young
ARS, N/A, USA

What's on Your Bucket List for Horticulture

(Poster Board #)

Mary Hockenberry Meyer*, University of Minnesota

We all have a bucket list, right? Re-learning fly-fishing; seeing the Aurora Borealis, the pyramids, and Villa d'Este; and learning to play chess are on Dr. Mary Meyer's bucket list. But what about a bucket list for horticulture – a list of the things we could do to advance our love of and life work with plants to help our world and everyone in it to eat well and thrive from being near plants? Yes, these could be big lofty goals or small personal steps. Meyer proposes it's time we thought about these goals and individually or collectively we work toward them purposefully. Meyer has a horticulture bucket list to share with you, and she hopes her thoughts will inspire you to develop a horticulture bucket list that will continue to advance the wonderful field of horticulture.

eOrganic: Science-, Practice- and Regulation-based Information for Farmers, Ag Professionals, Educators and Researchers *CEU Approved*

Coordinator: Alice Formiga
Oregon State University and eOrganic, Corvallis, OR, USA

4:15 PM – 4:30 PM

Eorganic: Information for Farmers, Outreach for Research Projects and Resources for Educators

Alice Formiga*, Oregon State University and eOrganic and Alexandra Stone*, Oregon State University

eOrganic publishes articles, videos, webinars, and online courses about organic farming and research at http://extension.org/organic_production. Articles and videos are peer reviewed and checked for compliance with national organic regulations, and eOrganic has archived over 250 recordings from organic conferences and webinars on current organic research topics. eOrganic has participated in 68 NIFA OREI and ORG projects and archived publications or presentations for at least 26 others, as well as Beginning Farmer, AFRI, RMA, SARE and other national and international organic research projects. Although many of the materials were prepared by researchers, the content is accessible for a general audience of farmers, and agricultural educators and service providers. The result is a publicly available collection of reliable information on organic farming and research that is increasingly being used in university courses for students of organic agriculture. Examples of how eOrganic resources are being used in organic agriculture classes will be provided.

4:30 PM – 5:00 PM

The Art of Writing up Your Science: How to Make Your Results Accessible to an Extension Audience

Annette Wszelaki*, University of Tennessee; Alice Formiga, Oregon State University and eOrganic and Javier Fernandez-Salvador, Oregon State University

Researchers and students will benefit from this training presentation, designed to provide useful tips for tailoring your research to an audience of farmers and agricultural educators and service providers. Researchers and students may need to communicate their results to farmer audiences as part of the outreach component of grants; yet some may not often work together with farmers, so might not be well acquainted with farmers' needs and priorities. In addition, they may not have experience writing and speaking to an audience who is less familiar with the scientific terms, acronyms, or statistical analysis that researchers use to publish their results in academic journals--yet who is much more knowledgeable about the practice and economic risks of crop production. Extension educators Annette Wszelaki of the University of Tennesese and Javier Fernandez-Salvador will discuss how to write for a farmer audience, and Alice Formiga of eOrganic will share information from eOrganic webinars on the kinds of questions farmers ask, as well as working with researchers to adapt their presentations for farmers. This information will inform students who wish to submit an article to eOrganic on their research or participate in future eOrganic article competitions.

Specified Source(s) of Funding: NIFA OREI and ORG

5:00 PM – 5:15 PM

Rapid Burndown: Capric and Caprylic Acid for Weed Management in Organic Vegetable and Specialty Crop Production

Tyler Mason* and Mark Edward Uchanski, Colorado State University

Abstract

Weeds are a major issue in organic cropping systems, and farmers need a variety of tools to manage them. Preventative cultural practices, mechanical cultivation, and hand weeding are common approaches to weed control in organic vegetable and specialty crop systems, but each management approach

has its limitations. Twenty percent acetic acid (a.k.a. horticultural vinegar) is one of few desiccant herbicides available to organic growers, but it is only somewhat effective on weeds ≤10 cm in height. In addition, it is expensive, which further limits its usefulness. Our objective was to evaluate a promising new option for non-synthetic weed control, a mixture of capric and caprylic acid (CA), which is allowable in organic systems "with restrictions" and rapidly burns down weeds via desiccation. We compared CA to acetic acid (AA) as a desiccant herbicide for weed control effectiveness and cost in an organic sweet corn system. A randomized complete block design with five weeding treatments was used for a field study in northern Colorado. The treatments were an untreated weedy check, a weed-free check, a single hand hoeing at the 4-leaf collar/5-leaf collar stage (V4/V5), AA applied at V4/V5, and CA applied at V4/V5. Both AA and CA were applied as a simulated shielded spray at 20% v/v (undiluted) and 9% v/v, respectively. Two weeks after application CA exhibited 78% weed control and AA exhibited 56% weed control compared to the untreated check. Moreover, CA was able to control weeds ≤23 cm in height, which is more than twice the size of weeds AA can effectively control. The single hand hoeing at V4/V5 treatment provided 66% weed control at two weeks. CA was about half of the cost of AA at \$95/25 m^2 and \$171/25 m^2, respectively. Neither CA nor AA reduced sweet corn ear number, but the average ear weight of the CA treatment (0.21 kg) was significantly higher than the untreated weedy check (0.18 kg). This study demonstrates that CA is more affordable and effective than AA for non-synthetic weed control in organic production. As such, CA may be a viable option to explore further for high-value specialty crop producers wanting to include an effective desiccant herbicide for weed management in their organic system plans.

Specified Source(s) of Funding: Colorado Department of Agriculture, Specialty Crop Block Grant Program

5:15 PM – 5:30 PM

Orchard Floor Management Practices for Establishing Organic Peaches in the Intermountain West

Anthony Whaley* and Jennifer Reeve, Utah State University

Organic peach production has been shown to produce similar yields to conventional orchards in Utah, but with higher revenues on average leading to a greater profit for the producer (Knudsen, 2015). In order to establish organic peach (*Prumus persica L.*) production and maintain yields, weed competition and nutrient supply must be managed. Organic peach trials at the Utah State University (USU) Kaysville Horticulture Research Station evaluated several organic orchard floor management practices - living mulch tree-row with grass alleyway, living mulch tree-row with birdsfoot trefoil alleyway, straw mulch tree-row with grass alleway, straw mulch tree-row with birdsfoot trefoil alleyway, tillage tree-row with grass alleyway, and weed fabric with grass alleyway. These trials have shown that birdsfoot trefoil (*Lotus corniculatus L.*) alleyways can reduce the need for intensive weed control and maintain nutrient availability during the establishment of organic peach orchards relative to conventional alleyway management techniques. Pest management is of concern in organic systems with increasing biomass on the orchard floor but has the potential to be managed. Fruit yields were comparable to conventional systems and represent an opportunity to increase profitability for the organic orchard. This publication outlines the best practices recommended for establishing organic peach orchards in the Intermountain West.

Specified Source(s) of Funding: USDA NIFA OREI, the Utah Department of Agriculture and Food Specialty Crop Block Grant program, and the Utah Agricultural Experiment Station

5:30 PM – 5:45 PM

Assessing the Quality and Possible Functions of Compost Extracts in Organic Systems

M. Benjamin Samuelson*; Rhae Drijber and Sam E. Wortman*, University of Nebraska - Lincoln

Compost extract (CE) is a suspension of soluble and particulate material from compost in water intended as an agricultural fertility input or biological inoculum. Popular practice and theory around CE suggests that it can promote crop health beyond its nutrient value, presumably by influencing microbial communities in the phytosphere. We review this body of knowledge and identify a need for predictors of CE efficacy. Little is known about the range of microbial composition of compost extracts from different parent composts or how CE may be predicted to influence plant growth when applied to seeds or to residues before soil incorporation. We completed a series of biological tests to characterize 10 compost extracts, including total microbial abundance by fatty acid methyl ester (FAME) profiles, microscopic counts, and the Soil Microbiometer® system, a lettuce seed phytotoxicity bioassay, and a *Pythium sp.* damping-off suppression survey on cucumber (*Cucumis sativus*) seedlings. Three compost extracts advanced to a greenhouse experiment testing effects on lettuce growth in residue-rich soils. Agreement of microbial abundance measures with FAME analysis was fair and poor, for microscope counts and the Soil Microbiometer® system, respectively. One CE retarded lettuce seed germination, two CE reduces damping off in cucumber, and the interacting effects of residue and CE influenced lettuce growth. High carbon residues reduced growth and CE had no effect in these treatments; however, inoculation of alfalfa residue with yardwaste and chicken manure CE increased lettuce growth 53%. These growth-promoting extracts contained less microbial biomass and microfauna than the vermicompost extract, which performed comparably to the controls. Results suggest that certain CE can enhance lettuce growth when applied to high nitrogen residues before soil incorporation. We underline that available testing is inadequate for predicting whether a particular CE will successfully deliver any of several possible benefits.

Specified Source(s) of Funding: Nebraska Agricultural ExperiNebraska Agricultural Exoeriment Station, North Central Regional Sustainable Agriculture Research and Education Graduate Student Grant Program, and the USDA NIFA Organic Transitions Program

Teachers Ignite! *CEU Approved*

Coordinator: Andrew R. King
Texas A&M University, College Station, TX, USA

Description:
Presenters have 5 minutes to introduce a novel pedagogical technique that they have found useful in the classroom, and then 5 minutes to demonstrate the technique. After each presenter, attendees will have approximately 10 minutes to discuss how they may use/modify the technique in their own teaching program. This format will allow for 4-6 presenters and attendee participation.

4:15 PM – 4:30 PM

Utilizing Social Media (Instragram) Outside of the Classroom to Enhance Learning Experiences
Todd P. West*, North Dakota State University

4:30 PM – 4:45 PM

How to Incorporate Team Activity, Oral and Visual Communicate and Cognitive Thinking in a Large Lecture
David W Reed*, Texas A&M Univ

4:45 PM – 5:00 PM

How to Keep Your Students Incentivized All Semester Long!
Sandra B. Wilson*, University of Florida

5:00 PM – 5:15 PM

From Micro to Macro: Growing Ag Literacy
Gary R. Bachman*, Mississippi State University Coastal Research and Extension Center

Thursday, July 25, 2019

Presidential Address and ASHS Annual Business Meeting

Presidential Address *(Poster Board #)*
Janet C. Cole*, Oklahoma State Univ

Keynote Speaker: Roger Kjelgren

Tree Response to Projected Global Change Temperature Increases Will Likely Vary with Species Water Use Strategy *(Poster Board #)*
Roger Kjelgren*, University of Florida
Recent climate and decadal downscaling of global climate models reinforce a trend towards more extreme drought and high temperatures. The gradient of hydric behavior will affect how horticultural species growth and water use respond to more extreme temperatures and drought. At one end is isohydric behavior that closes stomates to reduce transpiration and soil water depletion, and maintain less negative internal tension, but at the cost of reduced photosynthesis. At the other is anisohydric behavior that maintains high transpiration and photosynthesis at the cost of negative internal water tension and soil water depletion. More extreme temperatures and drought may affect horticultural species trending isohydric by limiting potential growth and potential carbon fertilization effect. Anisohydric trending species may tolerate higher temperatures and benefit from high atmospheric CO2, but may be at more risk of stress and poor performance due to greater soil water depletion and extended drought when non irrigated

Roger Kjelgren's area of expertise is tree physiology, with an emphasis on canopy level interactions with the atmosphere. He spent 25 years at Utah State University studying tree water use, drought stress, and urban water conservation. He is currently director of the University of Florida Mid Florida Research and Education Center in Orlando, still dabbling in water use research to keep his sanity.

Effects of Climate Change on Fruit Production *CEU Approved*

Coordinator: Derek Woolard
Valent Biosciences Corp, Libertyville, IL, USA

Description:
Three speakers will be discussing different aspects of the impact of climate on fruit production. A broad discussion of the impact of climate on fruit production will set the stage for more detailed discussions of inadequate chilling and effects of abiotic stress on post-harvest storage.

One speaker will be discussing impacts of climate across several aspects of fruit production from the beginning of a growing season to the end and will include a broad overview on shifting environments for tree fruit producing regions.

Another speaker will concentrate on the major issue of lack of chilling temperatures required to break dormancy at the beginning of a growing season.

Another speaker will present information about the impact of climate on the post-harvest aspect of fruit production.

The workshop will attempt to include a short live poll to learn the audience's opinions about the priorities for pomology research on climate change. Participants with smartphones that are willing to use cellular data, assuming there is a cellular signal, will be able to participate. Alternatively, we could get a sponsor to buy WIFI for the room for the day, if that is available. This is a chance to help identify future research needs.

10:30 AM – 10:50 AM

Global Warming and Inadequate Chill Accumulation in Temperate Fruit Trees

Gregory L. Reighard*, Clemson University

Temperate fruit trees such as apple, pear, cherry, and peach require dormant season cool temperatures to complete endodormancy so that flowers fertilize and leaves emerge normally in the spring. Recent and continuous global rises in mean annual temperatures are increasing the probability of marginal winter cold in traditional fruit production areas where many fruit tree cultivars risk poor flower set, irregular vegetative budbreak and/or early phenology (bloom). An example where the global increase in mean annual temperature has affected winter chilling is in the southeastern U.S., significantly impacting peach fruit set and cropping in 3 of the last 5 years. Continued temperature increases are predicted through the 21st Century. Fruit growers must adapt to the increased frequency of unusually warm winters using both proven and experimental cultural practices to both induce and break dormancy in deciduous trees using water, nutrients, hormones, chemicals, cultivar selection, and pruning methods. Current tools include on-site, real-time weather data to calculate chill hours, units or portions, so that winter chilling can be monitored and prediction models developed to assist in timing dormancy breaking horticultural practices. Historical and current data can also be combined and analyzed for El Nino or La Nina weather patterns to predetermine if chilling might be insufficient. Several compounds and fertilizers currently used with limited success are dormancy breaking agents, which include hydrogen cyanimide, Erger®, thidiazuron, potassium nitrate and calcium ammonium nitrate, but labelling remains a roadblock. Timing and rates are also critical when using these compounds, thus temperature models need refinement. Other management tools become necessary if dormancy issues persist into spring. For stone fruits, these include delayed pruning, cooling by whitewashing or water, retaining short shoots, and delaying thinning. The current trend of record global temperatures suggest that new dormancy breaking technologies and replacement of cultivars with new ones requiring much less chilling will be necessary to grow deciduous fruit crops in an increasing warmer environment. Fortunately, annotation of the *Prunus* genome is discovering genes and gene complexes (QTLs) that regulate dormancy, which breeders hope to incorporate into new cultivars via Marker Assisted Breeding that will lead to climate adapted fruit trees in the future.

10:50 AM – 11:10 AM

Impact and Mitigation of Shifting Seasons and Elevated Summer Temperatures for Apple Production in the United States

Lee Kalcsits*, Washington State University

The United States is among the leaders in fresh apple production. Increased volatility in temperatures will create less predictable snow packs, hotter summers, and changes to seasonal patterns that will affect orchard productivity and quality. High yields and reduced losses to disorders will be required to maintain profitability and to increase sustainability of production under these changing environments. Irrigated regions of the Western United States rely on a steady supply of water from melting snowpack in nearby mountain regions. In these areas, decreased summer water flows will require the development of water savings practices that do not negatively impact productivity or quality. Earlier bud break and later frosts will change dormancy and chilling patterns and change frost risk for most apple production regions in the country. Lastly, higher summer temperatures and earlier fruit maturity will increase the risk of sun-related damage that currently account for significant amounts of losses to the apple industry in Washington State. These losses may increase in areas traditionally unaffected by heat related disorders. All of these impacts will require changes to management practices that combine to conserve resources while still maintaining quality and productivity standards to ensure the profitability of tree fruit production in the United States. While some cropping regions have experienced recent drought events that have necessitated water conservation research, irrigated apple production systems have not suffered widespread impacts and as such, are not as well equipped to implement strategies to navigate changes in climate. Here, we highlight several strategies to mitigate the impacts of climate change and conserve water resources in apple production regions. These include the use of protective netting to optimize the light environment to reduce heat related losses while also conserving water through reduced evapotranspiration and reduction in evaporative cooling use. Other strategies include irrigation decisions that reduce postharvest losses due to heat and nutrient imbalances in susceptible cultivars. Lastly, we highlight the need for more research to better understand the plasticity of tree fruit species to develop cultivars that are better equipped to withstand the changing environmental pressures that are being experienced in traditional production regions. These combined strategies will better guide mitigation and adaption strategies that will help maintain apple production in the future.

11:10 AM – 11:30 AM

Will Climate Change Influence Tree Fruit Cold-Chain Quality and Losses?

David R. Rudell*, Tree Fruit Research Laboratory, USDA-ARS

Solar stress contributes to quality loss prior to harvest of many fruit species including apples, European pears, and sweet cherries. However, the impact following harvest can be less evident, ranging from overt appearance defects developing throughout the cold chain to less obvious quality loss or lot inconsistency. As climates in many temperate production regions of these crops are projected to continue warming, it is likely that quality defects related to solar stress will become even more prevalent. Sunscald, lenticel blotch, and cracking are examples of postharvest disorders that develop during the cold chain and are caused or exacerbated by direct sunlight and, potentially, air temperature, sometimes in combination with chilling stress. Fruit canopy position or even aspect with respect to sun exposure can also influence ripening and other quality phenotypes in part related to heat gradients contributed by shading. As may be expected, many of these phenotypic differences can be linked with metabolic changes during storage. In fact, metabolic differences resulting from differential sun exposure point to multiple pathways indicating influences on both physiology and structure and the considerable contribution sun exposure may have to inconsistency of quality and ripeness, even within a single tree. It also reveals potential solutions using these differences as bases for mitigating quality loss caused by differential sunlight exposure. Common pathways influenced by sunlight during storage, postharvest phenotypes impacted, and harvest and storage management opportunities using metabolic differences will be discussed.

Multiregional Assessment of Opportunities and Challenges of High Tunnel Organic Crop Production Systems *CEU Approved*

Coordinator: Xin Zhao
University of Florida, Gainesville, FL, USA
Moderators: Francesco Di Gioia
The Pennsylvania State University, State College, PA, USA
Shuresh Ghimire
University of Connecticut, Vernon, CT, USA

Description:
This interactive workshop will provide an excellent opportunity to bring together expertise, experience, and evaluation across different geographic regions to tackle an important task of identifying critical needs and priorities for high tunnel organic crop production research and extension toward enhancing long-term environmental and economic sustainability. The invited panelists will present research and/or outreach scenarios where effective approaches, strategies, and programs were successfully developed to address specific issues identified in high tunnel organic crop production systems in their work. Participants will join structured discussions of major successes and critical issues as well as research and outreach priorities for high tunnel organic vegetable production.

The overall goal of the workshop is to systematically address and compare the major successes and key issues with organic high tunnel production and management across multiple regions in the U.S. in order to develop a strategic plan outlining future research and outreach focus areas and build a productive collaborative partnership for resource portal and grant project development. A peer-reviewed journal publication on current status and future prospects is expected to come out of this workshop, and the idea of establishing a multi-state project on high tunnel organic crop production research and education will be brainstormed

10:30 AM – 10:50 AM

Introduction and structured regional discussions of high tunnel organic vegetable production successes and critical issues followed by panel discussion

10:50 AM – 10:55 AM

Addressing Challenges of High Tunnel Organic Vegetable Production in Subtropical Florida

Xin Zhao*, University of Florida

Humid environment with rapidly fluctuating seasonal temperatures, sandy soils with poor retention of water and nutrients, and high levels of biotic stresses present unique challenges to high tunnel organic vegetable production in subtropical Florida. Integrated management practices will be discussed for enhancing the role of high tunnels in promoting organic cropping systems.

10:55 AM – 11:00 AM

Integrating Cover Crops Successfully into High Tunnel Production Systems

Cary L. Rivard*, Kansas State University

Soil quality and health can be a major concern in high tunnel systems due to intensive production practices in addition to the exclusion of rain. We have identified strategies that organic growers can utilize in order to implement cover crops during fallow periods as well as between successive cash crops. This presentation will discuss the economic implications and challenges that must be overcome in order to successfully integrate cover crops into these intensive systems.

11:00 AM – 11:05 AM

Reduction in Incidence of Certain Common Pests and Diseases in Berry Crops with Changes in Plastic Cover Type and Modifications to Cultural Practices

Kathleen Demchak*; Richard P. Marini and Maria E. Cramer, The Pennsylvania State University

Under high tunnel production, some common pests have responded to changes in the light environment through changing plastic cover type, while others have been decreased by the employment of certain cultural controls which were made more feasible by using high tunnels compared to the open field. Specific examples of these situations with berry crops, which are susceptible to a number of pests and diseases, will be presented.

11:05 AM – 11:10 AM

PAR and the Number of Layers of Plastic Cover on High Tunnels

Sanjun Gu*, North Carolina Agricultural and Technical State University

In the plant hardiness zones 7 and above, it has been debatable about if one- or two-layer plastic cover should be used on a high tunnel. In this discussion, some preliminary results of PAR in winter and spring will be presented and discussed.

11:10 AM – 11:15 AM

High-Tunnels on the Texas High Plains: A Potential Solution for Growing Specialty Crops in a Windy, Semi-Arid Climate

Hyungmin Rho* and Charles M. Rush, Texas A&M AgriLife Research - Amarillo

The Texas High Plains is characterized by a semi-arid, windy climate, demanding high evapotranspiration for crops. High-tunnel production system in this region provides protection from the detrimental winds and helps reduce water use in growing specialty crops in the area, creating opportunities for regional producers.

11:15 AM – 11:20 AM

Organic and High Tunnel: Convergence and Divergence As System Drivers

Matthew D. Kleinhenz*, The Ohio State University-OARDC

This presentation would highlight scenarios and areas of decision-making in which certified-organic approaches and high tunnel use appear to be mutually reinforcing or at odds within some growers' experiences. Rotation, soil health management, and year-round production and marketing are three examples.

11:20 AM – 11:40 AM

Structured discussions to identify research and outreach priorities and compare them between different regions

11:40 AM – 12:00 PM

Brainstorming for developing collaborative partnerships to address critical issues and key challenges identified during this workshop

How Could Hemp Go in Florida: Early Days of the UF/IFAS Hemp Program

How Could Hemp Go in Florida: Early Days of the UF/IFAS Hemp Program *(Poster Board #)*

Zach Brym*, University of Florida

Uses of Vip Medium and Explant Sterilants for Tissue Culture without Autoclave and Laminar Flow *CEU Approved*

Coordinator: Hideka Kobayashi
Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems, Frankfort, KY, USA

Moderator: Hideka Kobayashi
Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems, Frankfort, KY, USA

Description:

In this hands-on demonstration workshop on tissue culture with sterilants, a series of activities are proposed. After a brief overview on tissue culture, three procedures (demonstrations on medium preparation, culture initiation and subculturering) will be demonstrated by the speaker and workshop attendees will have opportunities to participate. After the conclusion of activities, the workshop will be concluded with a discussion session, led by another speaker. The presenter will summarize the activities conducted and present questions to stimulate the discussion.

2:00 PM – 2:15 PM

Overview on Tissue Culture and Medium Sterilant

Teresita D. Amore*, University of Hawai‘i at Mānoa

2:15 PM – 2:35 PM

Medium Preparation with Msvip Hot, Initiation of Culture with Sirvip, and Subculturing

Hideka Kobayashi*, Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems

2:35 PM – 3:00 PM

Initiation of Culture with SirVip

Hideka Kobayashi*, Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems

3:00 PM – 3:15 PM

PMSubculturing

Hideka Kobayashi*, Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems

3:15 PM – 3:30 PM

Conclusion and Discussion

Alan H Chambers*, University of Florida TREC

Part 2: Oral Presentations

ORAL PRESENTATIONS

Monday, July 22, 2019

Organic Horticulture

Moderator: Alia DeLong
University of Florida, Gainesville, FL, USA

12:45 PM – 1:00 PM

The Effect of Poultry Manure and African Bush Tea (*Hyptis suaveolen*s Poit.) on Growth and Yield of Lettuce (*Lactuca sativa* L.)

Usman Ibrahim*; Jamila Aliyu and Abdulmumin Nafiu, Ahmadu Bello University

Poultry manure is a locally available and relatively cheap waste material that organic lettuce growers can use to improve yield and nutrient content of their crops. Similarly, African bush tea, which is considered an unwanted plant in the study area, is in abundance and has the ability to suppress weeds, pathogens, and pesst. The expected outcome of this research would make it possible to lessen the escalating effects of human diseases such as cancer arising from the use of chemical fertilizers and herbicides for lettuce production. Besides all these, farmers' income will improve when they use less chemical fertilizers and herbicides for growing crops. In order to achieve the above outcome a field experiment was conducted during the 2018 rainy season at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University Zaria to assess the effects of poultry manure and application of African bush tea on growth and yield of lettuce. The treatments consisted of five levels of poultry manure (0, 1.5, 3.0, and 4.5 tonnes ha^{-1}) and a control, which is the application of 593 kg N/ha^{-1}) and two levels of African bush tea (0 and 1.6 tonnes/ha^{-1}). The treatments were factorially combined and arranged in a randomized complete block design (RCBD), replicated tree times. All cultural practices involved in the production of lettuce were carried out as normal. Data collected was subjected to Analysis of Variance (ANOVA) using General Linear Model GLM of the Statistical Analysis System package and the means were separated using the Duncan's Multiple Range Test. From the results obtained, it can be concluded that application of 4.5 tons per ha of poultry manure gave the highest yield, while application of African bush tea gave no significant difference in the yield and weed control ability of lettuce. Based on the findings farmers are advised to use 4.5 tons per ha of poultry manure which gave the highest yield for lettuce. There is need for further study on the quantity of African bush tea on the yield and its weed control abilities in lettuce production.

Specified Source(s) of Funding: Tertiary Education Fund (TETund)Nigeria

1:00 PM – 1:15 PM

Suppressing *Verticillium Dahliae* through Compost Application

Ashraf Tubeileh, California Polytechnic State University-San Luis Obispo and Gregg Stephenson*, California Polytechnic State University

Soil-borne fungal pathogens, such as *Verticillium dahliae* Kleb., can devastate a wide range of annual and perennial crops. Sustainable management of pathogens is important for profitability and reducing the use of harmful chemicals. Organic soil amendments play an important role in supplying the nutritional needs of vegetable crops while contributing to disease control. The objective of this research was to determine the effects of grape and olive-pomace-based composts on soil-borne pathogen incidence. Field experiments were conducted in both organic and conventional systems during the summer growing season of 2018 on the Cal Poly, San Luis Obispo campus farm. Four different organic amendment treatments were tested including: olive-pomace-based compost, grape-pomace-based compost, dairy manure compost, and plant waste compost. Abundance of the fungal pathogen *V. dahliae* was assessed from soil samples collected every 6 weeks from May to November 2018. Olive, grape, and plant waste composts showed significant suppression of *V. dahliae* abundance at two weeks and 8 weeks post application when compared to the control ($p \leq 0.0008$). Insufficient evidence correlates farm management type with *V. dahliae* abundance after adjusting for treatment and time ($p = 0.1175$).

Specified Source(s) of Funding: CSU Agricultural Research Institute

1:15 PM – 1:30 PM

Effects of Organic Fertilization Rate on 'Vidalia' Onion (*Allium cepa* L.) Plant Growth and Mineral Nutrients of Leaves and Bulbs

Juan C. Diaz-Perez* and Jesús Bautista, University of Georgia

Vidalia onions (*Allium cepa* L.) are sweet, short-day, low pungency, yellow Granex-type bulbs that are popular in the U.S. because of their mild flavor. There are few reports on sweet onion plant growth in response to organic fertilization rate. The objective was to evaluate the effects of organic fertilizer rates on sweet onion plant growth and mineral

An asterisk (*) in front of a name indicates the presenting author.

nutrients concentration in leaves and bulbs. Experiments were conducted at the UGA Horticulture Farm, Tifton, GA in the winters of 2012-2013 and 2013-2014. There were five treatments [organic fertilizer 3-2-3 equivalent to 0, 60, 120, 180 and 240 kg·ha^{-1} nitrogen (N)]. Root, stem and bulb biomass of mature plants increased while the root-to-shoot ratio decreased with increasing fertilization rate up to 120 kg·ha^{-1} N. Foliar concentrations of N and Ca decreased while Cu concentration increased with increasing organic fertilization rate. Bulb Mg and Mn increased while P and Cu decreased with increasing organic fertilization rate. The N use efficiency decreased with increasing organic fertilization rate; the agronomic efficiency of N decreased quadratically. In conclusion, onion plant growth increased with increasing organic fertilizer rate probably because of augmented soil N levels. Plant nutrient deficiencies late in the season, even at high organic fertilization rates, indicates that preplant application of organic fertilizer was sufficient to cover plant nutritional needs only partially and that applications of N fertilizer later in the season may be necessary. High application rates of organic fertilizer (above those required by the crop) may have resulted in significant N leaching since it is unlikely that the crop used the majority of the N that was mineralized.

Specified Source(s) of Funding: Vidalia Onion Commission

1:30 PM – 1:45 PM

Co-Creation of Knowledge in Agroecology: Collaborating to Develop Sustainable Agricultural Systems

Alia DeLong*; Carlene A. Chase; Marilyn E. Swisher; Kaylene Sattanno; Xin Zhao; Oscar Emanuel Liburd and Zhifeng Gao, University of Florida

Rapidly changing economic, environmental and social conditions continually present new challenges to researchers and farmers alike. The purpose of this study was to use participatory methods to make decisions about research design in sustainable organic strawberry systems. This research combines the input of university researchers, biological scientists, and farmers to create rigorous research design, objectives and new knowledge collectively. Alongside biological data collection, we complement these data by collaborating with local farmers to ensure our research is relevant to industry interests and concerns. University of Florida researchers have used this method in research projects since 2014. Experience with this method shows that egalitarian decision-making enhances research quality through improved research designs, treatments, data collection techniques and output. This presentation details the results from three years of research in partnership with the United States Department of Agriculture (USDA) National Institute for Food and Agriculture (NIFA) investigating sustainable organic strawberry cropping systems in the Southeast. In the 2017, 2018 and 2019 strawberry season, we invited farmers to blindly assess our on-station research plots. An in-depth discussion followed where farmers proposed research objectives, suggested areas of investigation and ultimately developed recommendations for future research. Three years of assessments reveals that expertise from biological researchers and practical knowledge from growers are necessary for successful research projects. Biological researchers and farmers have distinct knowledge sets that can complement one another. Facilitating direct intervention of farmers in research development helps eliminate potentially impractical ideas. This type of collaboration can save considerable time and money that would otherwise be diverted to unproductive efforts. Implications in this study and future studies will be discussed. This work is supported by Organic Agriculture Research and Extension Initiative grant no. 2015-51300-24134 from the USDA National Institute of Food and Agriculture.

Specified Source(s) of Funding: . This work is supported by Organic Agriculture Research and Extension Initiative grant no. 2015-51300-24134 from the USDA National Institute of Food and Agriculture.

1:45 PM – 2:00 PM

Off-Season Cover Crops for Organic Strawberry Production in Florida

Emmanuel A Torres Quezada* and Carlene A. Chase, University of Florida

Broadleaf weeds, nutsedge, and plant-parasitic nematodes (PPN) can negatively affect strawberry yield in Florida. In organic production systems management of these pests requires that the primary management techniques should be preventive and cultural practices. Cover crops have been shown to be useful for suppressing weeds and PPN, while promoting soil health. Additionally, leguminous cover crops can serve as a nitrogen source for the strawberry crop. A field experiment was conducted between 2016 and 2018 to evaluate the effect of off-season cover crops on soil health, weed suppression and PPN densities in organic strawberry production in Florida. Sunn hemp (*Crotalaria juncea,* cv. Tropic Sun), hairy indigo (*Indigofera hirsuta*), and a four-way mix (sunn hemp cv. AU Golden, hairy indigo, *Crotalaria ochroleuca,* and *Aeschynomene americana)* were compared to a weedy control during the summer of each year. Following the cover crop treatments, four strawberry cultivars were established for evaluation in October of each year. A split plot design was used with cover crops in the main plots arranged in a randomized complete design with 4 replications and strawberry cultivars were assigned to the sub-plots. Data were collected on photosynthetically active radiation penetrating the cover crop canopy, leaf area index, cover crop biomass soil health score and PPN populations. Weed density and biomass were assessed during the cover crop and the strawberry crop. In 2016, sunn hemp resulted in 22% higher biomass than hairy indigo and the 4-way mix. In 2017, there was no difference biomass production among the cover crop treatments, while in 2018 the 4-way

mix resulted in the highest biomass compared to the rest of the treatments. There was no effect of the cover crop on soil health score, cover crop leaf area index, PPN populations, broadleaf, sedge and total weed density. However, cover crops reduced broadleaf weed biomass by 70% compared to the weedy control. This biomass reduction may be linked to light competition between the cover crop and the weeds as cover crops reduced light penetration through their canopies by 50%, on average, across the three years of the study. Longer than three years of cover crop use may be needed to impact soil health. The cover crops were selected for their reported resistance to sting and root-knot nematodes to which strawberry plants are susceptible. Future assessment of efficacy against PPN will be undertaken in a field with these PPN, which were absent from this site.

Specified Source(s) of Funding: Organic Agriculture Research and Extension Initiative grant no. 2015-51300-24134/project accession no. 1007441 from the USDA National Institute of Food and Agriculture.

2:00 PM – 2:15 PM

Effects of Leguminous Cover Crop, Compost, and Organic Fertilizer on High Tunnel Organic Production of Pac Choi and Spinach

Shufang Tian*; Xin Zhao and Zack Black, University of Florida

The interest of using high tunnel for extending vegetable production season and enhancing crop yield and quality is growing among organic and local growers in Florida. However, there is a lack of research-based information with respected to integrated nutrient management in organically managed high tunnel systems with sandy soils in the subtropical environment. The objective of this study conducted in Citra, FL was to assess the impacts of summer leguminous cover crop, compost, and organic fertilizer on vegetable performance and nutrient availability taking into consideration crop rotation under organic production in high tunnels. A split-split plot design with 3 replications was used with weedy fallow and cowpea planting prior to the vegetable season in the whole plots, preplant application of solid organic fertilizer vs. in-season fertigation with liquid organic fertilizer as the subplot factor, and application of different types of composts (i.e., yard waste compost, cow manure compost, vermicompost, and no compost) as the sub-subplot factor. Pac choi(*Brassica rapa L*. cv. Mei Qing) seedlings were transplanted into the high tunnel plots in Oct. 2018 and harvested 32 days later. Spinach(*Spinacia oleracea* cv. Corvair) was seeded in the same treatment plots 3 days after pac choi harvest without further addition of compost or organic fertilizer. In the pac choi trial, cowpea cover crop did not have any significant effect on crop yield and aboveground nitrogen accumulation. Preplant application of solid organic fertilizer resulted in higher plant dry and fresh biomass in the first two weeks after transplanting, while the fertigation treatment led to significantly greater fresh and dry biomass and nitrogen accumulation in the following weeks and at final harvest. The final yield was significantly higher in the yard waste compost treatment than other compost treatments. However, compost application did not exhibit any significant impact on nitrogen concentration. There was no significant difference among treatments in spinach yield at the first harvest. Yard waste compost resulted in a significantly higher yield than the no compost control at the second harvest and significantly increased the total yield. The pronounced effects of compost application and organic fertilization suggested the need for optimizing organic nutrient management in sandy soils under high tunnel production. The lack of cowpea cover crop effect implied the challenge of using short-cycle leguminous cover crops for meeting vegetable crop nutrient need in high tunnel organic systems, yet, the long-term influence on soil quality and nutrient dynamics deserve further examination.

Specified Source(s) of Funding: USDA OREI

2:15 PM – 2:30 PM

Integrating Poultry and Cover Crops into Organic Vegetable Production for Soil Health

Moriah Bilenky* and Ajay Nair, Iowa State University

Enhancing soil quality and health, nutrient cycling, and reducing off-farm inputs are a few basic guiding principles of organic agriculture. Despite these principles organic vegetable producers still find it challenging to create a holistic production system that includes integration of plant-animal production while also reducing off farm inputs. Integrating chickens into organic vegetable crop rotations could help create a system where on farm energy and nutrients are recycled with the added advantage of enhancing farm diversity, land use efficiency, and profitability.

This study is a three year project established in 2017 investigating changes in soil properties, poultry health, and farm profitability from integrated chicken and organic vegetable production. Three integrated annual crop rotation treatments were designed: vegetable-chickens-cover crop (R1), vegetable-cover crop-chickens (R2), and vegetable-cover crop (R3). Each rotation was replicated four times. Throughout the growing season soil samples were collected and analyzed for chemical and physical properties, labile carbon, and microbial activity, and presence or absence of *E. coli* and *Salmonella*.

Fertilizer application was reduced by up to half for the R2 treatment plots (chickens integrated in the fall). This shows a positive impact of having an integrated system where off-farm fertilizer inputs could be reduced by integrating chickens in the fall and manure is uniformly distributed through the use of movable chicken coops. Soil organic matter increased in all treatment plots from the start of the project in 2017 to the beginning of the 2018 growing season. Samples collected in October 2018 show increased labile carbon in R1 and R2 treatments indicating that integrating chickens can increase the active soil carbon. Microbial biomass increased

An asterisk (*) in front of a name indicates the presenting author.

in R1 and R2 treatments by the end of the 2017 growing season. The increase in microbial activity and labile carbon show promise in enhancing soil health and nutrient cycling in integrated organic production systems. Samples collected at the end of the 2018 growing season did not show presence of *E. coli* 0157: H7 or *Salmonella* after having chickens on them for two seasons. This demonstrates low risk potential of chicken manure application on successive crops that follow poultry within a rotation system.

This study was approved by the Institutional Animal Care and Use Committee. Partial funding for this study was provided through the North Central Sustainable Agriculture Research and Education Graduate student grant program.

Specified Source(s) of Funding: Partial funding for this study was provided through the North Central Sustainable Agriculture Research and Education Graduate student grant program.

Postharvest 1

Moderator: Mahnaz Kargar

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1:00 PM – 1:15 PM

Passive Modified Atmosphere Packaging Can Extend the Shelf Life of Spinach Stored in Non-Optimum Temperatures.

Konstantinos Batziakas*[1]; Shehbaz Singh[2]; Helena Pontes Chiebao[1]; Cary L. Rivard[1]; Jeffrey K. Brecht[3] and Eleni D. Pliakoni[1], (1)Kansas State University, (2)Curation Foods Inc., (3)University of Florida

Local fruit and vegetable small acreage production has been steadily expanding in the U.S. Fresh produce is highly perishable and will deteriorate rapidly if appropriate postharvest handling is not practised. However, small acreage producers have limited access to postharvest handling resources like optimum refrigeration conditions and many of the existing tools and techniques are not suitable for small acreage operations. Passive modified atmosphere packaging (MAP) is a relatively inexpensive technique that does not require specialised equipment and has a potential for maintaining the quality and extending the shelf life of fresh produce. Our objective was to determine the effect of passive MAP on the quality and shelf life of locally grown spinach (*Spinacia oleracea* cv. Corvair) when stored in non-optimum temperatures typical for locally marketed produce. Mature spinach leaves (320 g) were packaged in passive MAP bags, developed using the BreatheWay® technology, and non-MAP produce bags and subsequently stored at 13°C or 20°C. Spinach physical and nutritional quality was evaluated throughout its shelf life in terms of overall visual quality, water loss, surface colour, leaf firmness, electrolyte leakage, chlorophyll fluorescence, antioxidant capacity, and phytochemical content. Spinach that was stored in MAP bags reached headspace equilibrium at approximately 1% O_2 and 11% CO_2 at 13°C and approximately 3.5% O_2 and 6.5% CO_2 at 20°C. The main limiting factors for the control treatment, for both storage temperatures, was accelerated yellowing and water loss, while for the MAP treatment decay due to condensation limited shelf life. MAP packaging only slightly improved the visual quality of spinach stored at 21°C but resulted in a shelf life extension of 2 days at 13°C. There were no differences in antioxidant capacity and total phenolic content between the treatments at both temperatures throughout shelf life. Passive MAP can be an effective tool for extending the shelf life and maintaining the quality of locally produced spinach. Using a film with increased water vapour transmission rate (WVRT) could potentially mitigate the condensation issues of the MAP packaging and further increase the shelf life of spinach stored at non-optimum temperatures.

Specified Source(s) of Funding: USDA-NIFA AFRI Food Security GRANT 11451860

1:15 PM – 1:30 PM

Effects of Fumigation with Ethanol and Methyl Jasmonate on Quality and Phyto-Compounds Contents in Broccoli Florets during Storage

Arturo Duarte Sierra*, Instituto Tecnologico de Sonora and Joseph Arul, Universite Laval

Broccoli is a good dietary source of glucosinolates, flavonoids and hydroxycinnamic acids. These substances have been associated with prevention of cancer and cardiovascular diseases. But broccoli florets are also very perishable due to their high respiration rate and ethylene sensitivity. Postharvest treatments involving abiotic stresses have been evaluated to delay senescence in broccoli, however, the effect of these treatments on phytochemicals have not been completely explored. Broccoli (*Brassica oleracea*) florets were exposed to an atmosphere containing 10,000 ppm of ethanol at room temperature for 30- and 120-min. Exposure to methyl jasmonate (MeJA) treatments was done at room temperature using 1 ppm for 45 and 180 min. Yellowing of the florets was delayed using 10,000 ppm of ethanol on both exposure times compared with untreated florets, and chlorophyll titers were also superior with both doses compared with the control. Total phenols of florets increased by 15 % and 18 % with the application of the hormetic and high dose, respectively over the storage compared with unexposed broccoli. The titers of glucosinolates and hydroxycinnamic acids were enhanced by both doses of ethanol as well. Exposure of florets to 1 ppm of MeJA for 45 min delayed the yellowing of florets, however longer exposures produced yellowing after 21 days and significantly ($p<0.05$) increased respiration rate compared with non-treated florets. The total antioxidant capacity of florets was considerably reduced by both doses of methyl jasmonate; however, titers of hydroxycinnamic acids increased with both doses. The amount of total glucobrassicins in broccoli increased after the exposure of florets to both doses, but not significant differences were

observed in glucoraphanin content. In conclusion, ethanol treatments can effectively delay senescence and induce phytochemicals. In contrast, the effect of MeJA on quality is not substantial, however, it can be used to improve the phytochemical content of florets, especially of indole type

Specified Source(s) of Funding: Research Council (NSERC), Quebec Ministry of Agriculture, Fisheries and Food (MAPAQ) and National Council of Science and Technology of Mexico (CONACyT).

1:30 PM – 1:45 PM

Rapid Determination of Starch Content of Potato and Sweet Potato By Using NIR Hyperspectral Imaging

Wen-Hao Su*, University of California, Davis and Da-Wen Sun, University College Dublin

The potential of near-infrared (NIR) hyperspectral imaging for rapid evaluation of starch concentration (SC) in potato and sweet potato was investigated. The hyperspectral images of both samples were obtained, then the resulting reflectance spectra (R_S) were corrected and transformed into absorbance spectra (A_S), and exponent spectra (E_S). Full wavelength partial least squares regression (PLSR) models were established based on spectral profiles with measured reference values. Six groups of feature wavelengths were chosen from R_S, A_S and E_S based on two feature selection methods including regression coefficient (RC) of PLSR and the first derivative and mean centering iteration algorithm (FMCIA), and were successively used to build simplified models. The optimal models were obtained using FMCIA on the basis of the E_S. After further reducing the number of feature wavelengths, only six wavelengths (1028, 1068, 1135, 1208, 1262 and 1460 nm) were selected and utilized to develop the simplest FMCIA-Es-PLSR model for predicting SC, yielding a high accuracy with R^2_p of 0.963 and RMSEP of 0.023. In addition, the SC on potato and sweet potato were visualized based on an equation to apply the simplest models to spectral images.

1:45 PM – 2:00 PM

Assessment of Banana Ripening Using Conventional and Image Analyses

Rashid A Al-Yahyai*, Sultan Qaboos University and Samia Al-Maawali, College of Agricultural & Marine Sciences, SQU

Improving and grading for banana quality has become an important requirement to increase fruit exportation. At present, during postharvest processing, banana fruit is sorted and classified manually according to maturity as indicated by the peel color. This manual grading is a destructive method and labor-intensive. The objective of this study was to determine the efficiency of computer vision (CV) system with RGB color camera to evaluate the maturity of banana as indicated by the color of the peel and to predict the internal chemical characteristics, primarily soluble solid contents and starch. Three cultivars of banana (‘Cavendish’, ‘Malindi’ and ‘Milk banana’) were obtained from the local market. At every stage (from stage 2 to stage 7 of banana ripening), the samples were imaged individually using a color RGB camera. A software (ImageJ) was used to determine RGB color type and intensity. Whereas, pocket refractometer was used to measure total soluble solids (TSS). Results showed that CV can predict the amount of TSS and starch in the fruit. Hue and a/b color indices were more accurate to detect the amount of TSS and starch for all cultivars. As a result, a model for all three cultivars can be created from the data of all ripening stages (green to over ripe stages) of banana to predicate TSS and starch of sample from the skin color of banana.

Specified Source(s) of Funding: Sultan Qaboos University

2:00 PM – 2:15 PM

Antioxidant Activity of Six Different Banana Cultivars during Ripening

Mahnaz Kargar*[1]; Floyd M. Woods[1]; Marisa M. Wall[2]; J. Raymond Kessler[1]; Esendugue Greg Fonsah[3]; Edgar L. Vinson III[1] and Ramesh B. Jeganathan[1], (1)Auburn University, (2)USDA ARS, (3)University of Georgia - Tifton Campus

Banana (*Musa* spp.) is a rich source of phytonutrients and antioxidants in particular phenolic compounds providing health benefits to the consumers. Stage of ripening may have a profound influence on phytochemical content and bioactive compounds. Six banana cultivars varying in genotype including FHIA (AAAB), Hua Moa (AAB), Kandarian (ABB), Pisang Raja (AAB), Saba (ABB) and Williams (AAA) were selected. Fruits were harvested at full three-quarter stage of ripening, room ripened at 20°C and 95% RH and separated to four ripening stages of mature green, transitional, fully ripe and over ripe. Peel and pulp fruit samples were analyzed for total phenolic content. In addition, the antioxidant activity was determined based on DPPH and FRAP assay and reported as Gallic acid and Trolox equivalent. Results indicate that total phenolic content of peel was significantly higher than pulp. Therefore, banana peels could serve as potential source of bioactive compounds and can be utilized effectively without being wasted. ‘Pisang Raja’ (AAB) and ‘FHIA 1’ (AAAB) in peel and ‘Kandarian’ (ABB) and ‘FHIA 1’ (AAAB) in pulp were identified as the cultivars with the highest total phenolic content. In terms of antioxidant activity, in both Gallic Acid and Trolox equivalent, ‘FHIA 1’(AAAB) and ‘Pisang Raja’ (AAB) were determined as the cultivars with the highest antioxidant activity followed by ‘Kandarian’ (ABB), ‘Williams’ (AAA), ‘Saba’ (ABB), and ‘Hua Moa’ (AAB). A positive correlation between total phenolic content and antioxidant activity was also observed in all cultivars. Further research is needed towards isolation and identification of active compounds present in the extracts which could possibly be exploited for pharmaceutical use.

2:15 PM – 2:30 PM

Cross Cultivar RNA-Seq: Challenges and Perspectives

Loren A. Honaas*[1]; Eric Wafula[2]; Matthew Simenc[3]; Brittany Cook[3]; Heidi Hargarten[4]; David R. Rudell[1]; James P. Mattheis[1]; Claude W dePamphilis[2]; Joshua Der[3]; Stephen P. Ficklin[5] and John Hadish[5], (1)Tree Fruit Research Laboratory, USDA-ARS, (2)Penn State, (3)California State University, (4)USDA, ARS, Tree Fruit Research Laboratory, (5) Washington State University

The apple fruit marketplace is increasingly cultivar diverse. This diversity presents a number of production challenges, including identification of optimized postharvest practices. An emerging tool for postharvest apple fruit management is functional genomics. This approach can be leveraged to identify gene activity signatures that are associated with future fruit quality, which, with sufficient development can be deployed as biomarkers. However, the genetic diversity that is facilitating increased apple fruit marketplace diversity also presents key challenges for biomarker discovery and development. We discuss these challenges (for apples and more) and offer perspectives and solutions.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission, USDA

International Horticultural Issues

Moderator: Robin Brumfield
Rutgers, The State University of New Jersey, New Brunswick, NJ, USA

1:00 PM – 1:15 PM

Hit Play > Creating Engaging Online Videos with Researcher Footage to Promote the Value of Horticulture

Brenda Dawson*[1]; Hallie Casey[2] and Erin McGuire[1], (1)Horticulture Innovation Lab, (2)Navajo Technical University

The Horticulture Innovation Lab has created dozens of short videos to highlight horticulture research and its value, sourced from its global network of scientists who are working to advance fruit and vegetable innovations that help smallholder farmers earn more income and better nourish their communities. With research taking place in Africa, Asia and Central America, sending a communications professional from the University of California, Davis, management team to shoot video footage of all of the program's research projects while they are happening was unrealistic, so finding ways to collect video materials from researchers and creatively distill them into useful, attractive videos became necessary to reach broader audiences online. Domestic extension educators and communicators often face similar challenges with regard to being in multiple parts of a state or region at one time, but the costs and scope of international travel truly required additional ingenuity to find ways to crowdsource footage and has so far yielded three useful approaches with varying outcomes. In 2016, the program made a series of "lightning talk" videos that recreated researchers' conference presentations, combining audio recordings with timed slides to recreate an essential version of each presentation for viewers who were unable to attend the conference in Cambodia. In 2017, the program trained its researchers in how to shoot their own video footage with smartphones and how to edit video clips into short stories. Then each project team debuted a 2-minute impact-story video at the program's 2018 conference. In 2019, the program created a series of short video testimonials from stakeholders working with the research teams, to add farmer voices and in-country perspectives to a conference held in Washington, D.C., that was focused on the importance of horticulture. Researchers asked farmers one of three designated questions and supplied simple video clip responses for the program team to edit into a suite of video testimonials from Honduras, Nepal, Guinea, Kenya, Tanzania and Uganda. This presentation will share useful tips and considerations for creating each of these three types of videos, along with insights from video analytics that show varying rates of interest and success. Other research and extension professionals can use these video techniques to create engaging multimedia content that builds upon these ideas, in order to share their in-person experiences with wider audiences online.

Specified Source(s) of Funding: This project is supported by the Horticulture Innovation Lab with funding from the U.S. Agency for International Development, as part of the U.S. government's global hunger and food security initiative called Feed the Future.

1:15 PM – 1:30 PM

Horticulture for Nutrition Security

Elizabeth Mitcham*, University of California, Davis and Erin McGuire, Horticulture Innovation Lab

Progress towards global nutrition targets, including reduced stunting, under-nutrition, anemia, diabetes, overweight and obesity has been very poor in many countries. Consumption of fruits and vegetables positively contributes to achievement of these goals, but global consumption remains below recommended levels. In addition, we are not producing sufficient quantities of fruits and vegetables globally to supply this healthy diet, however, we are producing a surplus of whole grains, oils, and sugar over what is needed for a healthy diet. We need to place more effort promoting consumption of fruits and vegetables with advertising budgets closer to those used for snack foods and electronics. At the same time we increase demand, we need to increase production and reduce postharvest losses, especially in emerging economies and developing countries. The Horticulture Innovation Lab has funded research to enhance productivity of fruits and vegetables in emerging economies, including efforts to identify better-adapted varieties, test grafted plants with superior scions and resistant rootstocks, enhance access to irrigation systems for small-scale farms, and test various types of protected culture and conservation agriculture techniques. Postharvest practices in the developing world are generally rudimentary and losses are very high. Research into improved practices such as small-scale cold rooms, better packaging, and simple processing methods have been supported. Agribusiness development and market linkages have been identified as key needs for successfully improving delivery of fruits and vegetables to consumers and returns on investment to farmers. Demand generation is also critically needed. An overview of lessons learned from the Horticulture Innovation Lab's ten-year research portfolio will be highlighted.

Specified Source(s) of Funding: Horticulture Innovation Lab (USAID)

1:30 PM – 1:45 PM

Scaling Horticulture Technologies and Practices for Smallholder Farmers Utilizing the "Regional Center" Model

Archie Jarman*, Horticulture Innovation Lab at University of California Davis

Scaling technologies – both physical technologies and improved practices - developed in the United States for smallholder horticulture farmers in developing countries can be challenging. Distance hinders stakeholder involvement during design. Remotely anticipating constraints on the feasibility and adoption of a technology can impede effectiveness. Without a network of in-country stakeholders, disseminating a viable technology is difficult. To bridge the gap between U.S.-based researchers and in-country stakeholders, the Horticulture Innovation Lab at the University of California, Davis established "Regional Centers." The Regional Centers, housed within in-country universities, have pursued five core strategic goals: increase farmer knowledge of improved horticultural practices; test and disseminate regionally specific horticultural technologies; increase local adoption of horticultural technologies; improve the research and management capacity of host institutions; and, increase investments in and the number of entrepreneurs in horticulture. For eight years, Regional Centers at Zamorano University in Honduras and Kasetsart University in Thailand have evaluated, improved, and disseminated technologies generated by the Horticulture Innovation Lab's worldwide projects. These Regional Centers have solidified themselves as horticulture hubs of expertise for their regions – Latin America and Southeast Asia. The Centers conduct trainings and test technologies intended for local smallholder farmers, government ministries, private entities, and NGOs both on-site and externally. The strategic partnerships that the Regional Centers have established ensure their sustainability and the scalability of both their impact and of technologies designed to improve smallholder farmers' lives. The Regional Center at Kasetsart serves as Winrock's Feed The Future Asia Innovative Farmers Activity (AIFA) regional Innovation Hub and provides expertise in horticulture technologies being scaled in Nepal and Bangladesh. The Regional Center at Zamorano established a satellite center in Colombia through the "FundaPanaca" project, collaborates with NGOs working in Central America, and conducts trainings for extensionists from government ministries in Honduras and El Salvador. The success of the Regional Center model has inspired other Horticulture Innovation Lab projects to establish similar centers. In Tanzania and Rwanda, projects initiated centers specializing in postharvest handling of horticulture crops. In Cambodia, two new centers focus on composting and safe vegetable handling. In Guinea, a youth-focused horticulture training center houses technologies related to production and postharvest handling which are utilized for trainings and adaptive research. In terms of achieving scale, building on-the-ground individual and institutional capacity, and adapting technologies for smallholder farmers, the Regional Center model has proved profoundly effective and will continue to be encouraged by the Horticulture Innovation Lab.

Specified Source(s) of Funding: The Horticulture Innovation Lab at UC Davis with funding from the U.S. Agency for International Development, as part of the U.S. government's Feed the Future initiative

1:45 PM – 2:00 PM

Capacity Building on Produce Postharvest Management in Tanzania

Eleni D. Pliakoni*[1]; Kelly M. Gude[1]; Konstantinos Batziakas[1]; Cary L. Rivard[1]; Steven A. Sargent[2]; Theodosy J. Msogoya[3] and Ramadhani O. Majubwa[3], (1)Kansas State University, (2)University of Florida, (3)Sokoine University of Agriculture

Postharvest losses of fresh horticultural crops are a major challenge in Tanzania, ranging from 20 – 50% depending on the crops and management practices. The main reasons identified responsible for postharvest losses are the limited postharvest facilities, technologies, and access to knowledge. This project is a collaboration of researchers and extension specialists from Kansas State University (KSU) and University of Florida (UF), to build capacity at Sokoine University of Agriculture (SUA) in postharvest specialization of horticultural crops. The main goal is to provide students, farmers, traders, marketers, and agriculture extension educators who are working with fresh produce the tools and knowledge necessary to improve the quality and shelf life of their products and consequently reduce postharvest losses in Tanzania. More specifically, we helped develop institutional capacity at SUA by supporting a new curriculum and developing graduate level classes in postharvest management of fresh produce that help researchers and educators to conduct research and training in postharvest physiology and technology. Additionally, SUA faculty have worked closely with adult education faculty from KSU and UF in order to

An asterisk (*) in front of a name indicates the presenting author.

improve their teaching methods and pedagogy. We supported postharvest research teaching and extension at SUA by improving the existing infrastructure and introducing low-cost postharvest technologies that will be used for educational and training purposes. Finally, we worked towards building technical capacity for farmers, traders, marketers, and agriculture extension educators by developing and delivering training on appropriate postharvest handling methods. As of today we have trained 60 extension educators from government entities, private sector and NGOs. Also, we have trained 154 farmers and we anticipate to train approximately 400 by the end of the project. The increase in knowledge related to appropriate postharvest handling will result in the reduction of postharvest losses of fruits and vegetables throughout the supply chain. Our long-term goal is to help increase availability and access to nutritious vegetables and fruits that contribute to improving the livelihood of Tanzanians. This presentation will provide an overview of the project in addition to the results of the work thus far.

Specified Source(s) of Funding: USAID Horticulture Inovation Lab UC Davis

2:00 PM – 2:15 PM

Deploying Vegetable Seed Kits to Tackle Malnutrition in Cambodia, Kenya, Liberia, Tanzania and Uganda.

John Bowman*[1]; Ralph Roothaert[2] and Pepijn Schreinemachers[2], (1)USAID (United States Agency for International Development), (2)World Vegetable Center

The goal of the project was to contribute to reduced malnutrition, especially of vulnerable women and children in rural areas of Cambodia, Kenya, Liberia, Tanzania and Uganda through the production and consumption of vegetables as affordable sources of essential vitamins and micronutrients through the accelerated production and deployment (i.e. “scaling”) of diet-enhancing vegetable homegarden seed kits. The kits contained high proportions of traditional vegetables such as amaranth (*Amaranthus dubius*) and African nightshade (*Solanum scabrum*) that were easy to grow and high in micronutrient content. The specific objectives were to 1) increase nutritional awareness, 2) increase availability and supply of selected nutrient dense vegetables, 3) build the horticultural capacity of the target vulnerable groups, and 4) accelerate behavioral change for increased consumption of vegetables. A randomized control trial (RCT) methodology, coupled with a “difference-in-difference” estimator technique, was used in intervention and non-intervention villages that were monitored before and after project implementation (2 years). Interventions were the seed kits themselves and associated agronomic training, recipe training, and nutrition awareness-raising. Through the distribution of 44,121 seed kits, 40,273 farmers were sensitized to the production techniques and nutrition messaging, and 37,299 actually adopted new technologies after the trainings. Importantly, over 49,000 vulnerable children were reached by the production and nutrition interventions. RCT data aggregated over 1,768 households in Cambodia, Kenya, Tanzania and Uganda showed that the interventions increased the share of households producing vegetables by 43% in Cambodia and 17% in Tanzania and households in these countries adopted a range of new vegetable production method including seed mini packets. Households were able to extend the period for producing vegetables by 4.1 months in Cambodia and 1.3 months in Tanzania and produced a greater diversity of vegetables for home consumption and selling. The results did not show significant effects on dry season vegetable consumption for any of the countries except Cambodia, which suggests that home garden interventions may need to give greater emphasis to technologies to produce vegetables in the dry season. Nevertheless, nearly all participants perceived that their vegetable production, consumption and the quality of diets had improved as a result of the seed-kit based interventions.

Specified Source(s) of Funding: United States Agency for International Development

2:15 PM – 2:30 PM

Examining Nutrition Impacts and Sustainability of Horticultural Innovations in Southern Bangladesh

Angelos Deltsidis*; Amrita Mukherjee; Mohd Rezaul Islam; Michael Reid and Elizabeth Mitcham, University of California, Davis

The rural population of Bangladesh suffers from chronic malnutrition, despite the efforts from the government and the international donors. Climate change results in longer cyclone seasons with erratic weather conditions that reduce the capacity of the local population to secure year-round availability of nutritious foods, such as horticultural crops, which can provide the necessary micronutrients for a healthy lifestyle. Furthermore, the lack of accessible, low-cost methods to extend produce shelf-life after harvest reduces off-season consumption of horticultural crops. A number of innovative yet low-cost technologies have been implemented in selected locations in southern Bangladesh. These technologies aim to reduce food losses and extend the availability of nutritious foods while they support the incomes of smallholder farmers and entrepreneurs. Cooling is the most important method of food loss reduction, but is out of reach for most smallholder farmers due to high setup and running costs. The Horticulture Innovation Lab has installed 12 CoolBot-operated cold rooms that act as local, short-term cold storage points. Drying is a popular preservation technique in Bangladesh which often produces lower quality or contaminated products due to high humidity levels. Our team has installed innovative UC Davis-invented solar dryers, which facilitate airflow and reduce drying times while improving the quality of dried products. Seasonal flooding and expansion of aquaculture reduce the availability of suitable locations for family gardens. To provide growing space for such occasions, our team designed an experimental type of a bamboo raft to hold soil-less media for vegetable production, which is floated in the sunny part of fishponds. This technology can combat food insecurity when water levels in the region rise by providing small plant-growing platforms that can be used even during the rainy season. Our team gathers an extensive number of data points including inputs and outputs to extrapolate the profitability prerequisites and potentials for each technology using a UC Davis-developed sustainability model. Based on the preliminary data of this ongoing study, the implementation, operation and scaling of the above technologies supports household nutrition, adequate quality and quantity of food intake, and can potentially reduce illness while supporting inclusive economic development.

Specified Source(s) of Funding: USAID

2:30 PM – 2:45 PM

Empowering Women Greenhouse Owners in Antalya, Turkey By Teaching Them Best Management Practices

Robin G. Brumfield*[1]; Burhan Özkan[2] and Eda Ilbasmis[2], (1) Rutgers, The State University of New Jersey, (2)Akdeniz University

One in four people in Turkey are involved in agriculture, and women play an important role. In the Antalya Province, many women co-own and operate small vegetable producing greenhouses with their husbands. Although women in Turkey have important roles in the agricultural sector, previous research shows that the extension system in Turkey was underserved its female audience. To address this issue and empower women farmers, we developed Suzanne's Project in 2011. Suzanne's Project goals are to develop the technical and managerial capacities of Turkish women farmers through education, while supporting the region's economic advancement toward sustainable agriculture and gender equality. The objective was to examine the participants' socio-economic status, obtain a better understanding of their farming system and determine their level of interest in improved production technologies, business planning and management strategies. This also includes demonstrating new tools for best farm practices, building a sense of community and ultimately, empowering the women.

In September, October and November 2018, in Antalya, the Provincial Extension Service of Antalya which operates as part of the Ministry of Agriculture in Turkey conducted Suzanne's Project training for 79 women farmers who manage tomato greenhouses. Many of them also have a dairy cow for home milk consumption; or have a few sheep; keep bees; have a small orchard; produce mushrooms, cucumbers or aromatic plants for sale. Thus, 10 people from the Provisional Extension Service taught topics in agriculture and 5 veterinary extension personnal taught livestock and sheep management and sanitation. The women ranged in age from 18 to 55, have worked on the farm an average of 15 years, and 95% of them were married. They had an average of 2.4 children and primary school was the highest level of education for 75% of them. Their greenhouses averge 2,962 square feet with 80% of them owning their farms. Eight-seven percent of them received all of their income from their farm, but most had an annual gross income of less than 2000 Turkish lira($1US equals 5.3 Turkish lira). Now 62% use extension as their primary source of information on greenhouse production, but they also use the internet and friends for information. Since one of our main goals of Suzanne's Project is to empower women farmers, we were pleased to see that the primary reason 86% of the women gave for attending the class was to improve themselves and 29% said it was to improve their farm.

Specified Source(s) of Funding: EU Erasmus+

Water Utilization & Management 1

Moderator: Michael D Cahn
University of California Cooperative Extension, Salinas, CA, USA

1:15 PM – 1:30 PM

Water Uptake Dynamics for Adult Peach Trees in Florida

Carlos A. Zambrano-Vaca[1]; Lincoln Zotarelli*[1]; Kati Migliaccio[1]; Mercy A. Olmstead[2]; Richard C. Beeson Jr.[1] and Jose X. Chaparro[1], (1)University of Florida, (2)California Strawberry Commission

Low-chill peach cultivars allow Florida growers to become competitive by offering fruits earlier than northern states for premium prices. Due to the predominance of sandy soils in Florida, intensive irrigation management is required for most of the season to avoid water stress. Available irrigation recommendations and peach crop coefficients (K_c) were determined in arid and Mediterranean climates and they can overestimate water demand in humid subtropicalclimates. A two-yearstudy was conducted in Citra, FL aiming to determine the water requirements and $K_c$values for adult peach trees in humid subtropical conditions. Five soil probes equipped with four capacitance soil moisture sensors each were placed under the tree canopy, soil volumetric water content was recorded every 10 min and used to determine the daily soil water balance and crop evapotranspiration (ET_c). The ratios of daily $ET_c$and Penman-Monteith reference evapotranspiration were used to estimate $K_c$for phenological stages of adult (> 3yr old) peach trees. A water depletion coefficient was estimated and the threshold of 25.8% available soil water depletion before trees undergo water stress was determined. Daily ET_cranged from 0.22 mm·d^{-1}during dormancy to 3.65 mm·d^{-1}during shoot development. Daily K_c ranged from 0.30 during dormancy to 0.69 during fruit maturity. The values of K_c determined in this study provide a more accurate estimation of peach water requirements for humid subtropical climates compared to the $K_c$values determined for Mediterranean regions which

An asterisk (*) in front of a name indicates the presenting author.

tended to overestimate peach water demand under subtropical humid climate.

Specified Source(s) of Funding: Florida Department of Agriculture and Consumer Services - Block Grant (UF Contract # 98990)

1:30 PM – 1:45 PM

Optimizing Water Management in Celery Using Weather Based Scheduling

Michael D Cahn*, University of California Cooperative Extension; Lee Johnson, NASA ARC-CREST/California State University Monterey Bay; Sharon Benzen, USDA-ARS; Zhixuan Qin, University of California, Cooperative Extension and David Chambers, UC Cooperative Extension

Celery *(Apium graveolens)* is grown throughout the central coastal region of California. This shallow rooted vegetable is highly sensitive to soil moisture stress and is irrigated by a variety of methods, including drip, furrow, and sprinkler. We conducted a replicated field trial in 2018 to investigate yield response of drip-irrigated celery to applied water volume. Irrigation treatments were 50, 75, 100, 125, and 150% of estimated crop evapotranspiration (ETc), which was based on a crop coefficient model and reference evapotranspiration data from a nearby weather station. Irrigation treatments were replicated 6 times following a randomized complete block design. Transplants were established with sprinklers. Irrigation treatments commenced 22 days after transplanting (DAT) when the drip tape was installed. The crop was irrigated 3 times per week. Nitrogen fertilizer, totaling 380 kg/ha, was applied through the drip system once per week. Treatments were evaluated for commercial yield 85 and 93 DAT, and above ground biomass was evaluated 87 DAT. The 100% ETc treatment received a seasonal total of 34 cm of water and yielded 83 Mg/ha 93 DAT which was 10 Mg/ha higher than the average yield for the Salinas Valley in 2017. The highest commercial yield was measured in the 125% and 150% ETc treatments and equaled 102 and 108 Mg/ha, respectively, at 93 DAT. Seasonal applied water for the 125% and 150% treatments was 42 cm and 48 cm, respectively. The 150% ETc treatment had a higher incidence of pith breakdown and basal rot than the 100% ETc treatment. Yields from the 50% and 75% treatments fell below the Salinas Valley average. Above ground fresh and dry biomass increased with increasing applied water volumes, with a maximum of 165 Mg/ha of fresh biomass for the 150% ETc treatment.

Specified Source(s) of Funding: USDA-Specialty Crop Block Grant

1:45 PM – 2:00 PM

Optimizing Subsurface Drip Irrigation in Coarse Soil Onion Production

Scott B. Lukas*, Oregon State University, HAREC and Ruijun Qin, Oregon State University

Agricultural production in the Lower Umatilla Basin (LUB) in Oregon is under pressure as a potential contributor to nitrate pollution in the groundwater system. Onions are a primary crop produced in the LUB and are commonly irrigated with center pivot systems. Growers often irrigate the crop intensively to achieve optimal yield, which may result in undesirable water losses due to infiltration because of the native coarse-textured soils with a low water holding capacity. Irrigation management and nitrate leaching are closely linked and should be considered together when developing recommendations. Research from other regions with heavier soil types has demonstrated that drip irrigation systems can produce higher onion yields with reduced water and nutrient losses. However, little information is available on drip irrigation systems in LUB. The objectives of this study were to 1) evaluate drip irrigation flow rate and irrigation onset based on soil moisture in coarse textured soil; and 2) model water distribution throughout the soil profile to determine optimal irrigation parameters. Four treatments were evaluated in a random complete block design with five replications. Treatments consisted of two sub-surface drip irrigation flow rates of 0.26 and 0.49 L h^{-1}. At each flow rate, two values (10 & 20 kPa) of soil tension were used to initiate irrigation onset. Data indicated that onions uniformly established in all treatments. As the crop water demand increased, treatments that irrigated at 10 kPa had significantly higher vigor and plant height than those irrigating at 20 kPa. Onion yield and counts were significantly reduced by the 20 kPa irrigation onset threshold. Optimal yield and counts were found at 10 kPa onset, regardless of flow rate. Modeling of moisture indicated that with the 0.26 L h^{-1} flow dripline, irrigation water moved downwards during the initial 4 h after onset, then laterally through the soil profile. A deeper saturation occurred (15-40 cm), while the soil surface (0-15 cm) remained relatively dry. With the 0.49 L h^{-1} flow dripline, moisture moved downward within 1 h, then pushed laterally to saturate the uppermost portion of the profile, for the most part, irrigation water did not move downwards past 25 cm, which is optimal for onion root uptake and could minimize excess water and nitrate losses. Experimental procedures are currently evaluating nitrogen leaching correlated to irrigation flow rate and onset.

2:00 PM – 2:15 PM

The Effect of Biochar on Water Use Efficiency in Two Californian Sites

Elizabeth Crutchfield* and Milton E McGiffen, University of California

California has suffered many years of drought in the past decade. Increasing agricultural water use efficiency in California is important for maximizing value for growers and reducing strain on the environment. This research investigates the effect of biochar on crop water usage. Two research sites, one in the Central Coastal Ranges and one in the Desert, were set up. In Salinas Valley, biochar and compost amendments were applied to a new Pinot Noir planting. In the Desert Research and Extension Center, sugar beets followed by wheat were planting in varying rates of biochar. Watermark sensors were installed in both to monitor soil water over the growing season. Early measurements of growth don't show an increase crop growth in the presence of biochar. However, some plots showed greater soil moisture in plots with biochar in spite of equivalent growth.

Specified Source(s) of Funding: California Department of Water Resources

Human Issues in Horticulture/Local Food Systems

Moderator: Wesley Kline
Rutgers Cooperative Extension, Millville, NJ, USA

2:30 PM – 2:45 PM

Hunger and Horticulture in the U.S.

Michael A. Schnelle*[1]; Shelley E Mitchell[1]; Justin Quetone Moss[1] and Carla L. Goad[2], (1)Oklahoma State University, (2)oklahoma state university

Oklahoma ranks in the top 10 states for hunger and related challenges. A Hunger and Horticulture workshop was offered by the Oklahoma Cooperative Extension Service on May 22, 2018. The event focused on hunger and related issues in Oklahoma and also with consideration for the entire U.S. Topics included, but were not limited to, specific populations and their struggle with hunger, overfed and undernourished individuals, regional food banks, hunger relief gardening, increasing access to healthy foods, and food deserts. Horticulturists, professionals from allied disciplines (such as dietitians), and policy decision makers were invited to lecture. Workshop chairs foresaw a need for a better understanding of Oklahoma's current plight with hunger, so a hunger survey was administered to attendees at the beginning of the event. Participants demonstrated varying levels of awareness and opinions regarding hunger in Oklahoma.

2:45 PM – 3:00 PM

Young Industry Professionals' Perceptions of Extension and Future Research Needs

Caroline Warwick*[1]; Angela Colonna[2]; Liz Felter[1]; Roger Kjelgren[1] and Tracy Irani[1], (1)University of Florida, (2)UF/IFAS Mid-Florida Research and Education Center

All of agriculture is preparing for a generational shift as young industry professionals are poised to take over, with the 2014 U.S. Census reporting the average age of the American farmer being 58.3 years. Florida's nursery industry is not immune to this, where the reported average age of a horticultural operation is approximately 25 years and counting. The objective of this research was to understand young industry professionals', identified by researchers as those under 40 years old, perceptions of the university system including Extension and to understand their research and informational needs. Focus group research is a commonly used methodology that allows researchers to have a better depth of understanding of participants' reasoning and reactions to questions. During the focus groups, participants were asked specific questions about when, why and how they use University of Florida Extension resources when searching for information about the horticulture industry. The focus groups were audio recorded and transcribed, and were then analyzed using MAXQDA2018. Researchers found that young industry professionals used university resources most frequently when searching for solutions to problems, such as identifying and treating insect pests or identifying and treating plant diseases, and had nearly exclusive preference for online resources. Participants also mentioned using university events for networking with other professionals and as being satisfied with the easy-to-digest format of Electronic Data Information Source (EDIS) publications by the university. Young industry professionals also stated failure to be called back and timeliness of information to be some of the biggest barriers to working with universities and Extension. Participants also identified a need for universities to employ more individuals who understand food systems, specifically the local food movement and urban gardening, and have a better understanding of the nursery industry and plant production process. These findings can be used to guide university administrators in developing Extension programs and when defining the responsibilities of an Extension agent. Additionally, training new Extension employees in the areas of food systems, specifically vegetable production, and nursery plant production will be beneficial to the industry.

3:00 PM – 3:15 PM

Increasing Adoption of Improved Farming Practices through Participatory Research and Education

Cindy Fake* and Daniel Macon, University of California Cooperative Extension

Farmers face and manage a wide variety of risks in their operations on a daily basis. One common strategy used by agricultural producers is to rely on tried and true practices. Often, farmers wait until they see concrete evidence that a new practice works for other local farmers before they try it. The slow rate of adoption may impact farmers' ability to adapt to changing conditions and adversely affect the local environment and farm viability.

In the foothills of northern California, small-scale producers are challenged by high input and land costs, a declining and increasingly expensive labor force, and increasingly unpredictable weather. Over the last two decades, University of California Cooperative Extension, Placer and Nevada Counties has collaborated with producers to conduct applied field research, develop and deliver training. The focus of these efforts is on developing strategies and practices to address these local agricultural challenges.

Local farmers are partners in the development and delivery of UCCE research and extension efforts. Research has shown that if producers know and trust each other, they are more likely to adopt a practice being used by another producer. Our experience shows that involving farmers in the design and conduct of research and as trainers and extension experts leads to more rapid information dissemination and adoption of new practices. Producer involvement and peer-to-peer sharing about a practice also improve implementation of new practices by fine-tuning the method or technology with on-the-ground producer expertise.

This presentation will discuss several examples of participatory training and research and the impacts on adoption of new production and business practices. Examples include small group peer-to-peer education for specific commodity producers as well as participatory research on citrus production practices. The shared knowledge and implementation of new best practices within a producer community fosters innovation and strengthens the community and the local economy.

Specified Source(s) of Funding: Western Extension Risk Management Education and California Department of Food and Agriculture Specialty Crops Block Grant program

3:15 PM – 3:30 PM

Young Industry Professionals' Identified Challenges, Barriers and Needs of the Horticulture Industry

Caroline Warwick[1]; Angela Colonna[2]; Liz Felter[*1]; Roger Kjelgren[1] and Tracy Irani[1], (1)University of Florida, (2)UF/IFAS Mid-Florida Research and Education Center

As the horticulture industry prepares for an oncoming generational shift, understanding the challenges, barriers and needs identified by young industry professionals, defined as those under 40 years old, will be crucial for universities in developing relevant, valuable resources. The objective of this research was to understand young industry professionals' perceptions of challenges, barriers and needs of the horticulture industry. A commonly used qualitative research methodology, focus groups allow researchers to develop a greater depth of understanding, especially when trying to understand participant perceptions. Participants were asked to identify and elaborate on potential challenges and barriers they are facing in the industry as well as any needs they may have. After audio recordings of the focus groups were transcribed, results were analyzed using the constant comparative method with MAXQDA2018. One of the largest challenges or barriers faced by participants was working with university extension systems, as participants discussed long call back times from extension agents "if they are called back at all" and a lack of comprehensive resources, especially related to food systems. Developing comprehensive food system resources, especially those for urban audiences, should be a priority of Extension program development moving forward. Participants also discussed a seeming disconnect in communication between what was happening in the field and what was happening within universities. Universities should work to have more input from stakeholders when developing strategic plans, programming and in applying for funding. Finally, participants discussed the need for information provided by universities to be straight forward, brief, and most importantly, easy to access from a mobile device. Participants discussed the struggles of utilizing university resources, especially when accessing them from a cell phone or on-the-go. Future university materials should be made with the end user in mind and optimized for mobile reading.

3:30 PM – 3:45 PM

Improving Local Food Systems with Farm to School

Carl Motsenbocker*, Louisiana State University AgCenter and Crystal Besse, Louisiana State University Agricultural Center

The Louisiana Farm to School Program is centrally managed in the state Extension service and focuses on the three core elements of farm to school: local food procurement, school gardens, and education. Farm to school encompasses activities that connect communities with local food and local producers by changing food purchasing and education practices in schools. The state program is implemented with stakeholder coordinated efforts across multiple levels in the local food system. Louisiana Farm to School includes several innovative programs including: a web-based tool connecting local producers with schools and other consumers (MarketMaker); a statewide Louisiana Harvest of the Month (HOM) campaign with posters, protocols for implementation and sourcing locally produced fruits and vegetables, and HOM recipes; training workshops that provide methods and business strategies to producers (MarketReady); as well as training workshops for school nutrition personnel in best practices in local food procurement.

Specified Source(s) of Funding: USDA Food and Nutrition Service

3:45 PM – 4:00 PM

Microgreens Are a Promising Source of Phytochemicals for Urban Farming

Tianbao Yang*, USDA-ARS

Microgreens are seedlings of edible plants harvested 7 to 14 days after germination at the emergence of the first true leaves. In recent years, microgreen industry is emerging as an important part of urban farming. This presentation reports studies that comprehensively evaluated microgreen phytonutrient and technologies to improve microgreen production yield. Microgreens of selected species of *Brassica* family were grown, harvested, and tested for their nutritional values, along with their more mature counter parts. The effects of physical treatment (UVB) and plant growth regulators such as $CaCl_2$ on broccoli microgreen yield and levels of phytonutrients were also evaluated. Results demonstrate that microgreens contain abundance of various antioxidant compounds, with the exact concentration dependent on the plant species. In general, carotenoids, tocopherols, phylloquinone, and total phenolic compounds were high at younger growth stages (microgreens and baby greens). However, higher total ascorbic acid contents were found in mature red cabbage (91.8 mg/100g FW) and mature broccoli (118.8 mg/100g FW) than in their younger counterparts, respectively. Broccoli microgreens had four-fold greater total glucosinolates than mature broccoli leaves and florets.. Preharvest application of $CaCl_2$ and UVB boosted microgreen yield by 50% and improved overall visual quality and shelf life. These treatments significantly increased the content of total glucosinolates by around 70%. Thus microgreens have the great potential to be an important dietary source of phytochemicals for urban farming.

Specified Source(s) of Funding: USDA-ARS

4:00 PM – 4:15 PM

Local Labeling Awareness and Perceptions across State Lines

Kathryn Fife* and Ben Campbell, University of Georgia

Local labeling is an important issue within the horticultural industry as many producers have devoted considerable resources to advertising their product is local. Further, all states have implemented some form of local labeling program to increase local purchasing. As states expand the reach of these programs, the programs begin to compete as awareness and perception moves across state lines. Using an online study of around 1,500 consumers in the Southeastern U.S. we look to identify how state labeling programs are viewed in nearby states. Notably, we assess awareness, perception, and impact on purchasing of these programs in their "home" state as well as nearby states. Specifically, we evaluate the Georgia Grown, Certified SC Grown, Got to be NC Agriculture, Fresh from Florida, Buy Fresh, Buy Local, and Pick Tennessee Products, Kentucky Proud, Farm Families of Mississippi, and Louisiana Grown programs. Our results indicate that local labels are better perceived in their home state, while also impacting purchase to a higher degree. Further, we find that residents are aware of other state's labels, though this effect decreases the farther away the state is from the local branding effort. This information is critical for states and retailers wanting to expand their reach into other states. For instance, if awareness for a label is high in a state, but perception is low then a state's effort should focus on changing perception. However, if awareness is low then efforts should focus on increasing awareness.

4:15 PM – 4:30 PM

Food Safety Practice Changes on New Jersey Farms As a Result of Produce Safety Alliance Trainings

Wesley L Kline*; Meredith V. Melendez and Jennifer Matthews, Rutgers Cooperative Extension

The fresh produce industry is under increased pressure to improve their food safety practices. Historically food safety has been market driven through buyer required third party audits. The Food Safety Modernization Act Produce Safety Rule (FSMA PSR), which went into effect for the largest farms on January 26, 2018, makes food safety regulatory for fresh produce growers. This rule is the result of large-scale human pathogen outbreaks associated with produce typically consumed raw. While these outbreaks are commonly associated with large scale wholesale production, farms of all sizes and distribution types are affected by the FSMA PSR.

Rutgers Cooperative Extension, collaborating with the New Jersey Department of Agriculture and the Produce Safety Alliance (PSA), have been the educational provider for the Food and Drug Administration (FDA) approved food safety curriculum. The Rutgers On-Farm Food Safety team has provided the PSA training for the produce industry in New Jersey since 2016 and delivers full day certificate based educational workshops covering worker health and hygiene, soil amendments, wildlife and domestic animals, pre- and postharvest water use, postharvest handling and sanitation and developing an on-farm food safety plan. This training covers the basic information for growers to comply with the Produce Safety Rule.

From December 2016 to May 2018, 364 participants were trained, 163 of those participants with valid email addresses were surveyed and 41 returned the survey for a 25% response rate. The evaluative online survey was created in Qualtrics™. Participants surveyed were asked 18 questions ranging from demographic information to changes made on the farm as a result of taking the PSA training.

Survey results show that 83% of the respondents are responsible for the food safety on their farm and 79% have farmed over ten years. Of these respondents, 71% sell their produce through wholesale channels and 99% were able to maintain or add new market access. The most significant changes were in the areas of worker health and hygiene and post-harvest handling and sanitation.

Under worker health and hygiene, improved worker training, jewelry policy, better signage and updated wash facilities were among the changes made. For post-harvest handling and sanitation, participants indicated improvements made were increased cleaning and sanitation of tools, harvest containers and equipment and the creation of standard operating procedures. Survey results are being used to develop more advanced training to meet the specific needs of New Jersey produce growers.

Growth Chambers and Controlled Environments 1

Moderator: Shane Palmer
University of Georgia, Athens, GA, USA

An asterisk (*) in front of a name indicates the presenting author.

3:00 PM – 3:15 PM

A Revised Method for Estimating Phytochrome Photo-Equilibrium

Paul Kusuma* and Bruce Bugbee, Utah State University

Plants use the photoreceptor phytochrome to sense and respond to shade. The ratio of active phytochrome to total phytochrome (also known as phytochrome photo-equilibrium or PPE) has been predicted by measurements of spectral distribution and weighting factors published from multiple sources. This estimation is often well correlated with plant morphology under a spectral distribution that only changes in quantity of far-red photons. However, it is unreliable when changing ratios of colors below 700 nm. This may be the result of several factors: 1) Variation in PPE weighting factors among studies. 2) The values are primarily for phytochrome-A in oats. 3) There are interactions among photoreceptors. 4) Weighting factors come from estimations of phytochrome conversions in etiolated tissue. The dominating effect of chlorophyll in leaf tissue means that phytochrome is not exposed to the incident radiation above the leaf. Instead, phytochrome perceives a spectral distribution enriched in green and far-red. Our data indicate that the estimation of PPE in green leaves is improved by multiplying the spectral distribution by leaf transmission, then applying the weighting factors to the transmitted spectra.

3:15 PM – 3:30 PM

Yield and Fruit Quality of Strawberry (*Fragaria* x *ananassa*) 'Albion' and 'Cabrillo' Under Ambient and Supplemental HPS and LED Lighting

Jonathan A. Allred* and Neil Scott Mattson, Cornell University

Strawberry cultivation in the United States has been increasing over the past two decades. In North America, challenges associated with field production (labor, water, and soil disease) have led to interest in soilless controlled environment agriculture (CEA) systems. To date, insufficient published research exists on the influence of supplemental light quantity/quality on commercially available cultivars. The objective of this research was to determine the effect of supplemental light from either high pressure sodium (HPS) or light emitting diode (LED) sources on strawberry yield and Brix content. The trial was conducted using strawberry cultivars 'Albion' and 'Cabrillo' in two glass greenhouses in Ithaca, NY. Data collection began with 5 month old plants on January 1, 2019 after an establishment period of 2 months under their respective treatment conditions. The experiment consisted of one LED supplemental light treatment (Philips GreenPower LED toplights DR_{90}/B_{10}-LB), one HPS supplemental light treatment (Gavita pro 6/750e DE Flex) and an ambient light treatment (control). For both light treatments, a target daily light integral (DLI) of 15 mol•m^{-2}•d^{-1} with a maximum photoperiod of 20 hours was maintained using quantum sensors connected to microcontrollers running an algorithm to control light and shade. For the ambient light treatment, night interruption lighting was implemented with 2 µmol•m^{-2}•s^{-1} incandescent lights from 2200 to 0200 to maintain flower initiation. A total of 30 replicates per cultivar per treatment were planted at a density of 10.76 plants•m^{-2} with 3 plants per pot. 'Cabrillo' had the greatest total marketable fresh weight (TMFW) across all treatments, which was 0.9, 2.48, and 3.03 kg•m^{-2} for the Ambient, LED and HPS treatments, respectively. The TMFW for 'Albion' was 0.55, 1.88, and 1.68 kg•m^{-2} for the Ambient, LED and HPS treatments, respectively. Mean berry fresh weight was greatest under LED for both 'Albion' and 'Cabrillo' at 17 and 19 g, which was about 15% greater than the Ambient and HPS treatments for 'Albion' and about 20% greater for 'Cabrillo'. 'Albion' had the highest Brix across all treatments at 7, 8 and 9 °Bx for Ambient, LED, and HPS, respectively. While for 'Cabrillo', brix content was 5, 7, and 7 °Bx for Ambient, LED, and HPS, respectively. Future research is underway to evaluate the effects of lighting on additional fruit quality and sensory attributes.

Specified Source(s) of Funding: New York State Energy Research and Development Authority

3:30 PM – 3:45 PM

Biomass Allocation in Three Subspecies of *Brassica Rapa* Grown Hydroponically in a Greenhouse

Shane Palmer* and Marc W. van Iersel, University of Georgia

Brassica rapa contains several morphologically distinct subspecies. To optimize production in controlled environments, it is important to maximize resource allocation to marketable tissues, which may be achievable through environmental manipulation. Despite their genetic similarity, dry matter allocation among *B. rapa* subspecies differs but there are no baseline comparative studies. Obvious morphological differences among subspecies indicate physiological differences in resource partitioning during growth, which may be especially pronounced during different developmental stages. 'Niseko' turnip, 'Asian Delight' pakchoi, and mizuna were grown from seed in a greenhouse using arcilite media. Five harvests were performed at one-week intervals starting 26 days after planting (DAP). There was no difference in total biomass among subspecies at the first harvest; however, biomass of the subspecies diverged over time. Mizuna had highest biomass in all four subsequent harvests, while pakchoi had the lowest biomass. Mizuna likely outperformed turnip and pakchoi due to its large leaf area capturing more light for photosynthesis. Relative biomass of tissues were initially similar among subspecies; leaf blades, petioles, and roots comprised about 60, 25, and 15% of total biomass at first harvest, respectively. Biomass allocation shifted over time as plants developed stronger sinks. Sink filling in turnip roots initiated between 34 and 42 DAP and roots comprised 52% of total biomass at final harvest while leaves and petioles decreased to 29% and 19%, respectively. In both mizuna and pakchoi, relative biomass of leaves and roots decreased as petioles gradually increased over time. Leaves accounted for the largest fraction of biomass in mizuna during all harvests. The relative biomass of petiole tissue gradually exceeded that of leaf tissue in pakchoi. Root tissue comprised the smallest biomass fraction during all harvests for both mizuna and pakchoi. Specific leaf area (SLA) initially was similar for all three subspecies (372 cm^2 g^{-1}) and decreased over time. Final turnip, mizuna, and pakchoi SLAs were 280, 212, and 249 cm^2 g^{-1}, respectively. The decrease in SLA was associated with an increase in chlorophyll content index (CCI) among all three subspecies over time. Pakchoi had the highest CCI across all five harvests, peaking at 36 DAP and leveling off. CCI values in turnip and mizuna were similar to each other during all harvests. These patterns of biomass accumulation in turnip, mizuna, and pakchoi reflect distinct developmental and morphological changes that diverge as plants age, and may provide opportunities for improving harvest index by manipulating sink strength of targeted tissues

Specified Source(s) of Funding: This project was funded by USDA-NIFA-SCRI Award Number #: 2018-51181-28365, project Lighting Approaches to Maximize Profits

3:45 PM – 4:00 PM

Effects of Varying Light Intensity on Instantaneous Water Use Efficiency in Lettuce and Petunias

Laura E Reese* and Marc W. van Iersel, University of Georgia

The cost of dehumidifying the humid air generated by plant transpiration in vertical farms contributes to the high power costs of HVAC in these systems. Reducing transpiration while maintaining photosynthesis should reduce HVAC costs, while maintaining yields. Under increasing light intensity, the transpiration rate increases linearly and photosynthetic assimilation rises to meet an asymptote. Since instantaneous water use efficiency (WUE) is defined as the transpiration rate divided by photosynthetic assimilation rate, under increasing light intensity, it theoretically reaches a maximum and then plateaus or declines. In this experiment, two different spectra of white light varying in the ratio of blue to red, and in the percentage of far-red light were used to perform photosynthesis-light response curves on ‘Green Salad Bowl’ lettuce and ‘Purple Wave’ petunias at 400 and 800 ppm CO_2. The instantaneous WUE curves reached a maximum or asymptote under both lights and in both CO_2 concentrations. Water use efficiency tended to be higher under the white light with a larger fraction of red and far-red light, compared to the light with more blue. It was also higher at higher CO_2 concentrations. Thus, water use efficiency, and thus HVAC costs, can be increased by increasing light intensity or CO_2 concentration, as well as by manipulating the light spectrum.

Specified Source(s) of Funding: This project was funded by USDA-NIFA-SCRI Award Number #: 2018-51181-28365, project Lighting Approaches to Maximize Profits

4:00 PM – 4:15 PM

Nutrient Management Regime Affects Water Quality, Crop Growth, and Nitrogen Use Efficiency of Aquaponic Systems

Teng Yang* and Hye-Ji Kim, Purdue University

Sustainable nutrient management is of critical importance to achieve high crop yield and quality and to improve nutrient use efficiency in agricultural production systems, but has not been fully established for aquaponics. The objective of this study was to determine the effects of feeding regime on water quality, crop performance and yield, and nitrogen (N) use efficiency in recirculating aquaponic systems. The same amount of total N (120 g) was applied to aquaponics with different feeding regimes: aquaponic increasing feeding (AIF; the standard feeding regime), uniform feeding (AUF), and intermediate feeding (AMF), for one-month production of eight vegetable and herb species. Crops grown in AIF and AUF showed contrasting results in yield and SPAD value (chlorophyll content), and therefore were further evaluated for nutrient profile in aquaponic solution and crop growth and performance compared to those in hydroponics (HYD), using herb (basil, chia), leafy vegetable (Chinese cabbage, Mizuna, Swiss chard, lettuce, pac choi), and fruity vegetable (cherry tomato) species. AUF improved water quality by reducing average concentrations of harmful compounds (i.e., NO2-N and Na) compared to AIF and increased crop growth and yield similar to those in HYD. Particularly, AUF tended to increase concentrations of mineral nutrients (i.e., NO3-N, PO4-P, Ca, and Mg) in aquaponic solution during the first week after transplanting, while decreasing the concentrations of harmful compounds in comparison to AIF. Regardless of feeding regime, aquaponics reduced fine root growth in leafy vegetables and herbs, compared to that in hydroponics. Overall, vegetables and herbs grown in AUF had a greater photosynthetic rate (Pn) from the first to second week after transplanting and throughout production period, and showed higher SPAD value and leaf total N content to the level similar to or slightly lower than HYD. Overall, AUF increased N use efficiency (NUE) of the system by 30% and up to 600% compared to those in AIF and HYD, respectively. In conclusion, aquaponic crop production and N use efficiency can be increased by uniform feeding regime as it improves water quality and nutrient availability for better seedling establishment, consequently enhancing quality and/or yield of vegetables and herbs in aquaponics.

4:15 PM – 4:30 PM

An Effective Algorithm for Controlling Greenhouse Light to a Target Daily Light Integral Using Dimmable Supplemental Lights.

Geoffrey Weaver* and Marc W. van Iersel, University of Georgia

Lighting recommendations for greenhouse crops are often made in terms of the daily light integral (DLI), the total amount of photosynthetically-active radiation received by a crop in a day. Methods for controlling greenhouse lighting to a target DLI using on/off control have been previously described. We developed an algorithm for DLI control which makes use of the dimmability of light-emitting diode (LED) lights, and accounts for the behavior of a nominal distribution of daily sunlight intensities. The objective was to provide exactly enough light to reach a target DLI within a specified photoperiod if supplemental light is needed, and provide no excess light if it is not needed. This algorithm was applied to typical meteorological year data for five U.S. cities (Athens, GA; Elmira, NY; Kalamazoo, MI; Seattle, WA; Yuma, AZ) with several photoperiods (16 to 24 hours) in MATLAB using a custom script. Simulations were conducted for each city and photoperiod based on reaching a target DLI of 17 mol m^{-2} d^{-1} with a maximum LED photosynthetic photon flux density (*PPFD*) of 200 µmol m^{-2} s^{-1}. For Athens, GA the DLI from sunlight alone was less than 17 mol m^{-2} d^{-1} on 98 days. With a 16-hour photoperiod at this location, excess light was provided only on days for which sunlight alone exceeded the target DLI, and this occurred on 10 days (3.4 mol m^{-2} yr^{-1} total annual excess from the LEDs). The target DLI was not reached on 35 days, with an average deficit of 1.9 mol m^{-2} d^{-1}, which was partially due to the limited *PPFD* output of the LEDs. With a 24-hour photoperiod (Athens, GA), excess light was provided on only one day, and the target DLI was not reached on two days (0.04 mol m^{-2} d^{-1} average deficit). Results were comparable at the other locations, with improved accuracy observed at longer photoperiods. The algorithm was least successful when applied to the Seattle, WA data with a 16-hour photoperiod; supplemental light was required on 199 days, excess light was provided on 23 days (10.4 mol m^{-2} yr^{-1} excess), and the target DLI was not reached on 137 days (average 3.2 mol m^{-2} d^{-1} deficit). To be applied in a greenhouse setting, this strategy only requires measurements of *PPFD* made at canopy level, dimmable LED lights, and a simple microcontroller. The algorithm controls greenhouse lighting to a target DLI with reasonable accuracy and can be readily implemented.

Specified Source(s) of Funding: This project was funded by USDA-NIFA-SCRI Award Number #: 2018-51181-28365, project Lighting Approaches to Maximize Profits

4:30 PM – 4:45 PM

Green Light Benefit Photosynthesis at High Light Level

Jun Liu*, University of Gerogia and Marc W. van Iersel, University of Georgia

Green light is traditionally considered to be less photosynthetic active than red and blue light. However, green light can penetrate deeper into leaves and the absorbed light can be used efficiently. We investigated the magnitude of enhancing photosynthesis by green light and the underlying photosynthetic mechanism. We constructed photosynthetic light response curves and CO_2 response curves (A/Ci curves) for different light spectra on 'Green Tower' lettuce (*Lactuca sativa*). The maximum quantum yield of CO_2 fixation (moles of CO_2 fixed per mol of incident photons at very low *PPFD*) of each spectrum was calculated as the initial slope of the light response curves. From A/Ci curves, maximum carboxylation rate (V_{cmax}) and maximum electron transport rate (J_{max}) were estimated. In this study, red, green, and blue lights were tested, as well as red/green and blue/green mixtures at different ratios. Among monochromatic lights, red light had the highest quantum yield of CO_2 fixation (0.066 mol·mol^{-1}). Mixing 20%-80% green light with either red or blue light did not affect quantum yield. At a PPFD of 200 µmol·m^{-2}·s^{-1}, red and 80% red+20% green resulted in the highest photosynthetic rates, ~ 7.5 µmol·m^{-2}·s^{-1}. Blue, green and mixtures of these two colors yielded the lowest photosynthetic rates (5.8 - 6.2 µmol·m^{-2}·s^{-1}). At high PPFD (1,000 µmol·m^{-2}·s^{-1}), red, green and mixtures of red/green light yielded the highest photosynthetic rate (~16.2 µmol·m^{-2}·s^{-1}), while blue and blue/green light mixtures had lower photosynthetic rates (14.2 µmol·m^{-2}·s^{-1}). Green light and red/green mixtures achieved the highest maximum net photosynthetic rate (19.6 µmol·m^{-2}·s^{-1}) among all spectra. Blue and 80% blue+20% green lights had the lowest maximum photosynthetic rates (16.8 and 17.8 µmol·m^{-2}·s^{-1}). We also found that green light is efficient at upregulating Rubisco activity (as indicated by V_{cmax}), and potentially has the highest electron transport rate at high *PPFD*. In conclusion, green light is photosynthetically efficient at high *PPFD*. At *PPFD*s relevant for supplemental lighting in vegetable production, red and 80%red+20%green lights have the highest photosynthetic rate. The benefit of green light on photosynthesis likely results from its deep penetration into leaves and canopies. Therefore, enhancement of photosynthesis by green light is assumed to be more pronounced in whole canopies than single leaves. The magnitude of benefit of green light on whole canopy photosynthesis needs further study, as do potential morphological and quality effects of different LED spectra.

Specified Source(s) of Funding: This project was funded by USDA-NIFA-SCRI Award Number #: 2018-51181-28365, project Lighting Approaches to Maximize Profits

Plant Nutrient Management 1

Moderator: Nicholas Frederick Reitz
Department of Plant Sciences, University of California, Davis, Davis, CA, USA

3:15 PM – 3:30 PM

Investigating the Role of Reactive Oxygen Species and Abiotic Stress in Development of Calcium Deficiency Disorders.

Nicholas Frederick Reitz*, Department of Plant Sciences, University of California, Davis and Elizabeth Mitcham, University of California, Davis
Calcium deficiency disorders in horticultural crops cause significant losses each year to the produce industry. Blossom-end rot (BER) in tomatoes is often used as a model system for studying calcium deficiency in fruit, as it is associated with reduced total tissue and apoplastic calcium concentrations. BER in tomatoes is characterized by discoloration, water-soaked tissue, and cell death in the distal portion of the fruit. Previous research suggests calcium deficiency disorders are also associated with reactive oxygen species (ROS) accumulation and abiotic stress. This research investigates the connections between calcium deficiency, abiotic stress, and ROS metabolism in tomato BER development. Tomato plants were grown under low calcium conditions with BER inducing stresses (drought stress and high salinity irrigation) and compared to unstressed plants as control. Catalase and peroxidase activity were assayed in blossom-end pericarp tissue of stressed and control fruit to test for conserved responses to calcium deficiency over different abiotic stresses. Stem-end pericarp tissue and tissue adjacent to BER affected tissue were also assayed in control fruit. Histochemical staining and gene-expression analysis were used to investigate cell response to ROS accumulation. Results showed a significant increase in soluble and ionically bound peroxidase activity and a significant decrease in catalase activity in BER affected tissue. These trends were conserved between drought stressed, high salinity irrigated, and control plants. Tissue adjacent to BER tissue exhibited reduced catalase activity compared to stem-end pericarp tissue in BER affected control fruit. Preliminary fluorescence microscopy results have indicated higher ROS accumulation in the water-soaked region of BER affected fruit compared to healthy tissue. These results suggest a peroxidase dependent mitigation of ROS accumulation. Of interest is the increase in ionically bound peroxidase activity, which is localized in the cell wall. Gene expression analysis showed increased expression of a lignification associated peroxidase gene in BER affected fruit. Toluidine blue O staining results suggested production of lignin in BER affected tissue. BER development is most prevalent during early cell expansion and treatment with gibberellic acid, a cell expansion promoting plant growth hormone, has been shown to induce BER development. Our results suggest that normal cell expansion may be disrupted through peroxidase mediated lignification in BER tissue and may play a significant role in BER development.

3:30 PM – 3:45 PM

Exogenous Abscisic Acid Application Affects Strontium, Rubidium, and Nitrogen Isotope Tracer Uptake and Distribution in *Malus x domestica* Borkh.

Raquel Gomez*, Washington State University
Nutrient imbalances, and more specifically the relationship of potassium, magnesium and nitrogen to calcium, have been linked to physiological disorders in fruit like bitter pit in apples (Malus x domestica Borkh.). The use of isotopically labeled nitrogen, and nutrient analogs such as strontium and rubidium provide a direct quantification of uptake and distribution that is not possible with bulk mineral analysis. Here, the objective was to understand how abscisic acid (s-ABA), one of the major plant hormones that has been implicated in stress responses, influences nutrient uptake and partitioning between above ground and below ground parts of the tree. In this experiment, 10 atoms% ^{15}N, Strontium (Sr), and Rubidium (Rb) were applied to Gala, Granny Smith, and Honeycrisp apple trees in 10 gallon pots in a split-plot design with cultivar as the main factor and were either treated with ABA 250 mg/L or 500 mg/L or an untreated control. Overall recovery rates of each tracer reflected the mobility of their nutrient analog. Strontium had an average tracer recovery rate of 3.9%, followed by ^{15}N with 14.6% recovery and finally Rb with 15.1%. Independent of treatment, Gala significantly absorbed more tracer followed by Granny Smith and Honeycrisp for Rb and Sr but not ^{15}N. However, treatments did not significantly affect tracer uptake. The ratio of Rb and ^{15}N to Sr was the lowest for the control, followed by high concentration of ABA and then the low concentration of ABA. When considering root to shoot distribution, ^{15}N and rubidium were higher in the roots when treated with ABA and lower in the above ground tissue. In the case of Sr, uptake was in such minute amounts no significance was seen based on treatment and distribution. These finding are consistent with previous literature showing the low mobility of Sr and high mobility of Rb and N. Here, a combination of tracers were used to identify scion-level variation in the response to manipulation of plant transpiration with exogenously applied ABA. These results have implications in the understanding of the link between plant transpiration and nutrient uptake and distribution in apple.

3:45 PM – 4:00 PM

Nitrogen Use Efficiency Changes with Different Fertigation Timing in Apple Production

Bi Zheng Tan*; Nigel D. Swarts and Dugald C. Close, Tasmanian Institute of Agriculture
Fertilizer nitrogen (N) is a key input to the overall N budget in conventional intensive apple production systems. Understanding of uptake and utilization is important as tree N reserves drive bud break and early leaf growth, critical for apple yield and quality. Yet currently nitrogen use efficiency (NUE) is typically less than 40% in these systems. A strategy to optimize the NUE is to match tree N demand to fertilizer N supply. This study investigated timing of application, using ^{15}N stable isotope, as an approach to optimize NUE in a commercial orchard located in the Derwent Valley region of Tasmania, Australia using ‘Gala’ apple trees

grafted on M26 rootstock planted on sandy loam soil. Apple trees were drip-fertigated with 30 g N tree^{-1} (approx. 50 kg N ha^{-1}) of 5% ^{15}N enriched calcium nitrate at: pre-harvest (three weeks after full-bloom); post-harvest (one week after harvest); 50-50 split (half rate at both pre- and post-harvest) or; unfertigated as a control. Fruit quality was assessed at harvest and 8 weeks post-harvest. To determine NUE, whole trees were excavated at dormancy, separated into different organs and total N and ^{15}N content of the different organs were measured. The percentage of N derived from fertilizer (NDF) was used to determine partitioning of applied N throughout the tree and overall NUE. No significant differences between unfertigated control and those that received nitrogen treatments were found for fruit yield, size, firmness, starch index, total soluble solid content at harvest or 8-weeks post-harvest. Intensity of red color and red color coverage was significantly reduced, and background color was significantly greener in 50-50 split treatment relative to the other treatments. NUE was highest in trees treated with pre-harvest fertigation (27.8%), followed by post-harvest fertigation (19.5%), and 50-50 split treatment (16.3%). In general, 23% of the pre-harvest fertigated N taken up by apple tree was partitioned to the fruit, while buds of tree that received pre-harvest application contained nearly 4-times the amount of N than buds of trees that received post-harvest applications. The post-harvest N fertigation had significantly greater N allocation to storage (17.5% NDF) in all woody tissue than other treatments (9.7% and 9.3% NDF for pre-harvest and 50-50 split fertigation treatment respectively). The results suggested that pre-harvest fertigation optimized NUE and that N applied pre-harvest was allocated to supporting current season growth whilst post-harvest application was allocated to storage.

Specified Source(s) of Funding: Horticulture Innovation Australia Limited

4:00 PM – 4:15 PM

The Effect of Biochar Application on Soil Health and Legume Crop's Growth and Yield in Hawaii.

Amjad Ahmad*[1]; Hue Nguyen[1]; Theodore J.K. Radovich[1]; Koon-Hui Wang[1]; Jari Sugano[1]; Jensen Uyeda[1]; Sharon Motomura[2]; Joshua Silva[1] and Kylie Tavares[1], (1)University of Hawaii at Manoa, (2)University of Hawaii, College of Tropical Agriculture and Human Resources

Improving soil health is crucial for better nutrient mineralization, especially from organic fertilizers. Three consecutive field trials were conducted at the University of Hawaii, on an infertile Oxisols with low pH and potential micro-nutrient toxicity, between 2018 and 2019 to evaluate the short- and long-term effect of one-time biochar application rates and one application each growing season of fertilizer type and nitrogen (N) application rates on soil health parameters and legume crops growth and yield. The study was conducted as factorial in split plot design with 3 replicates. Biochar application rates were randomly distributed in the main plots (31.8 X 4.5 m each), and combinations of fertilizer type and N application rates were randomly distributed in the sub-plots (4.5 X 4.5 m each). The biochar was obtained from Pacific Biochar Co. and made from macadamia nut shell at 500^{O}C. At each growing season, 3 crops growth and yield (leaf chlorophyll content, total biomass, and yield) and soil health parameters (root-knot nematode population, Rhizobium nodules development, and CO_2 level) were collected using Solvita kit. The results showed a significant increase in the legume crops growth and yield by 20% under biochar application, compared to control treatment (no biochar application). Rhizobium nodules development was significantly increased by 50% under biochar application compared to control treatment. Root-knot nematode's root-galling index declines significantly with biochar application. The results showed a steady and significant improvement in soil health and legume crops growth and yield at the 3rd growing season compared to the 1st growing season.

Specified Source(s) of Funding: Western Sustainable Agriculture Research and Education (SARE)

4:15 PM – 4:30 PM

Fertilizer Rate and Timing on Yields, Soil Fertility and Cation Contents of *Telfairia Occidentalis*, *Solanum Macrocapon* and *Amaranthus viridis* in Southwest Nigeria

Christianah Tinuola Oladoye[1]; Mary Kemi Kemi Idowu*[1]; Durodoluwa Jospeh Oyedele[1]; Francis Tope Olatoberu[1]; Ojo Kolawole Adekunle[1]; Odunayo Clement Adebooye[2] and Kehinde Taiwo Taiwo[1], (1)Obafemi Awolowo University, (2)Osun State University

The low activity clay content results in low soil exchangeable cations and crop productivity in the Southwest Nigeria. Most fertilizers applied to the soil for vegetable production are lost through leaching or runoff. The study examined the effects of fertilizer rate and time of application on yield, soil exchangeable cations and cation contents of *Telfairia occidentalis*, *Solanum macrocapon* and *Amaranthus viridis*. This was with a view to establishing the appropriate fertilizer application methods for vegetable production in Southwest Nigeria. The experiment was located at the rainforest (Ilesha) in southwest Nigeria. The experiment was a Randomized Complete Block Design laid out in a split plot arrangement with four replicates. The main plot was time of application of urea N: at planting and at two weeks after planting, sub plot was five levels of urea at 0, 20, 40, 60 and 80 kg N ha^{-1}. Basal application of organic fertilizer (3.5% N) at 5 tons ha^{-1} was made a week before planting except for 80 kg N ha^{-1} plot (which is the farmers practice). Soil physical and chemical properties were examined prior experiment. Soil exchangeable bases were determined after harvesting of the vegetables. *Telfairia occidentalis* shoot was harvested at five weeks after planting (WAP), *Solanum macrocarpon* shoot was harvested at seven WAP and *Amaranthus viridis* shoot was harvested at four WAP. Shoot above ground biomass

per plot was determined and dry matter estimated. Calcium, Mg, K and Na contents of the vegetables were evaluated. The data generated were subjected to statistic analysis. The data generated were subjected to analysis of variance and the means separated using Duncan's New Multiple Range Test at 5% level of probability.

The results showed that fertilizer rate had significant effect on the yield of the three vegetables. On the other hand, time of fertilizer application had no significant relationship on the yield and the nutrient contents of the three vegetables. Application of 20 kg N ha^{-1} along with 5 tons OF ha^{-1} were optimal for *S. macrocarpon* and *A. viridis* while 40 kg N ha^{-1} along with 5 tons OF ha^{-1} were optimal for *T. occidentalis*.

It was concluded the fertilizer rates sustained the soil fertility and also gave balanced Ca, Mg, K and Na compositions in the vegetables.

Specified Source(s) of Funding: IDRC-DFATD/CIFSRF Grant No.; 107983

Teaching Methods 1

Moderator: Jessica Davis
Colorado State University, Fort Collins, CO, USA

3:15 PM – 3:30 PM

Youthmappers: International Service Learning While Solving the World's Problems

Peter M. Hirst* and Chad Blevins, USAID

Through YouthMappers, students in both the US and developing nations participate in GIS mapping of undermapped areas of the world. Projects are wide ranging, and cover the fields of agriculture, healthcare, democracy, business and emergency response. Recent examples of projects include mapping the location of soybean production areas and value chains in Ghana, describing incidence and impact of malaria in Zambia, mapping infrastructure in Kenya to support community advocacy for improved services, and disaster risk reduction mapping in Bangladesh. The opportunities for real-world challenges to be addressed by YouthMappers chapters are limited only by the imagination.

The USAID YouthMappers program comprises a network of 141 chapters in 41 countries. These student-led efforts result not only in data generation, but student capacity building and empowerment. Leadership opportunities are numerous including cohorts of Leadership Fellows, Research Fellows, and Visiting Open Data scholars. An alumni network has been formed to provide a mechanism for continued involvement and contribution after YouthMappers join the workforce. YouthMapper chapters function as university clubs, but there could also be the potential to incorporate these activities into a formal class or independent research projects. They use open geographical data, such as OpenStreetMap, to address locally defined development challenges worldwide. Projects are coordinated and data stored by the GeoCenter within USAID in Washington DC. Students from virtually all colleges across our universities could potentially play a role in these projects, giving students experience working in multi-disciplinary teams. YouthMappers is service learning that offers students opportunities for global engagement, leadership development, and both technical and non-cognitive skill development while addressing real-world challenges.

Specified Source(s) of Funding: USAID

3:30 PM – 3:45 PM

Portraits of Inclusion: Creating a Welcoming Environment for Women and People of Color

Jessica G. Davis*[1]; Jennifer Bousselot[1]; Jane Choi[1]; Kelly Curl[1]; Elizabeth Hobbs[1]; Yaling Qian[1]; Tracy Smith[1]; Cassie Rosch[2] and Shannon Archibeque-Engle[1], (1)Colorado State University, (2)Cassie Rosch Photography

Many of us have experienced walking into an environment and immediately feeling a sense of belonging or welcome. In contrast, many of us have also experienced walking into an environment and immediately feeling that we were unwelcome and did not belong. In our educational institutions, physical artifacts, the human created cultural objects and representations, communicate important messages about our educational climate and values. Bulletin boards, signage, decorations, and other artifacts serve as communicators of cultural values. These physical artifacts, then, may be viewed as powerful nonverbal communicators of climate, especially equity climate. These value representations tell current and prospective students, as well as faculty and staff, who and what are valued. The communication of cultural expectations shapes the learning environment, and these expectations support and/or constrain learning.

The Department of Horticulture & Landscape Architecture at Colorado State University is a unique blending of art and science that is found in few other singular departments across the University. It is also a department that is disproportionately dominated by men, both in the faculty ranks and student enrollment. Our goals with this project are to shine a light on both the art and the science in our department, to celebrate the contributions of women to our disciplines, to inspire our students, and to foster a climate of inclusion and gender equity—which hopefully will lead to increased female undergraduate and graduate student numbers and retention of those students. A photographic exhibition of women leaders in the fields of Horticulture and Landscape Architecture will be displayed in our Department after a public exhibition in April 2019. The exhibition showcases women with significant contributions and achievements in the fields of horticulture and landscape architecture. Women have been selected from an array of racial, ethnic, class, sexual orientation, gender, ability, religious, and cultural backgrounds so that our students will see role models they can relate to among these women. Museum-quality photographic portraits are accompanied by brief biographies of the women in their own words. There will be an opening reception including some of the featured

An asterisk (*) in front of a name indicates the presenting author.

women, who will discuss their involvement in the project and their experiences as females working in their respective fields.

Specified Source(s) of Funding: Colorado State University College of Agricultural Sciences

3:45 PM – 4:00 PM

Student Demographics and Performance Characteristics Correlated with Final Course Grades across Multiple Years of Four Undergraduate and Graduate Plant Materials Courses

Michael A. Arnold*, Texas A&M University

Data was collected from four plant materials courses over eighteen years, two at the undergraduate level, Trees and Shrubs for Sustainable Built Environments (HORT 306) and Plants for Sustainable Landscapes (HORT 308), and two at the graduate level, Plants for Landscape Design (HORT 608) and Plants for Landscape Design II (HORT 609), and analyzed for trends in student performance and benchmarks which might be associated with student success. Data included student enrollment, midterm grades, final grades, number of unexcused absences, student reported study times for various activities, student major, student experience (class rank), whether the courses were required or not, and perceived difficulty levels of the courses. The frequency of A and B grades increased during the most recent three or four year span in response to grading and assessment changes that emphasized study and assessment of chunks of related information, while moving comprehensive testing to designated midterm and final assessments. Midterm grades were highly predictive of final course grades in all four courses with $R^2 = 0.91$ (HORT 306) and $R^2 = 0.77$ (HORT 308) for the undergraduate courses, and $R^2 = 0.64$ (HORT 608) and $R^2 = 0.64$ (HORT 609) for graduate courses, at $P \leq 0.001$. This suggests a major key to success was getting off to a strong start. The only other benchmark significantly associated with final course grades were the number of unexcused absences which were all negatively correlated at $R^2 = -0.54$, -0.42, -0.50, and -0.50, for HORT 306, HORT 308, HORT 608, and HORT 609, respectively, at $P \leq 0.001$. Hence, consistent attendance was another key to success. Lesser changes between midterm and final grades were observed for fall than spring courses, particularly for seniors. Self-reported time spent studying was not correlated ($P \leq 0.05$) with final course grades, suggesting efficiency of study may be more important than length of time spent studying for the courses. Perceptions of courses as moderately difficult on average (7.5 – 8.0 out of 10.0) were remarkably stable overall, but varied considerably by major, means of 5.3 to 8.4, and experience, 7.3 for seniors to 8.1 for freshman. In general, majors from biological, agricultural, and basic science areas achieved higher grades in the undergraduate plant materials courses than those from social sciences, education, or arts curricula; however this was not predictive of individual students' grades.

4:00 PM – 4:15 PM

Status of Horticulture Programs and Student Enrollment at 140 US Colleges and Universities

John M. Dole*, North Carolina State University and Susan E. Yoder, Seed Your Future

From 9 July to 1 Nov. 2018 252 two-year colleges and 100 four-year universities were surveyed regarding the status of their horticulture programs. We received 83 responses from the two-year colleges (33% response rate) and 57 responses from the four-year universities (57% response rate); of the latter, 38 responses were received from land-grant universities and 19 from other four-year universities. The 2018 survey updated an earlier, although shorter, survey completed in 2014. At the time, we surveyed 152 two-year colleges and 76 four-year universities and had a 41% and 71% response rate, respectively. The overall number of undergraduate students is stable, with a majority of institutions either keeping the same number, or increasing, in the last five years (63%). The majority of students arrive in the department as incoming freshman, representing 39%, 37% and 45% of new students for two-year, land grant and non-land grant universities, respectively. However, internal transfers, external transfers and "other" (early college students at community colleges) are growing in significance. For example, in land-grant institutions, 27% of undergraduates are internal transfers and 34% are external transfers. The overall number of graduate students is stable, with enrollment at a vast majority of institutions either maintaining the same number or increasing in the last five years (86%). Horticulture includes a broad range of subjects, with greenhouse (cross-commodity) the most commonly-offered curriculum. Other topics taught by at least 10% of the institutions from at least one educational segment (two-year, land grant or non-land grant universities) included fruits, nuts, and/or vegetables (including viticulture); horticulture business, entrepreneurship, and/or marketing; IPM; landscape design (small scale) and/or construction and contracting, turfgrass, and woody ornamentals and floriculture (including arboriculture, interiorscaping). The most common degree offered is an Associate degree with 72% of the institutions offering at least one Associate degree. Departmental identity appears to have stabilized; in 2014 19% of four-year horticulture departments were in the process of or anticipated being combined with other departments compared with only 7% in 2018. For all institutions responding, 43% have horticulture departments or a department with horticulture in the title, 18% were never separate and 21% and 5% were combined either more than five years ago or less than five years ago, respectively.

Specified Source(s) of Funding: Seed Your Future

4:15 PM – 4:30 PM

Seed Your Future Update: Reaching 1 Million Students and Counting

Susan E. Yoder*, Seed Your Future; John M. Dole, North

Carolina State University and Mary Hockenberry Meyer, University of Minnesota

Seed Your Future- the movement to promote horticulture and inspire more young people to pursue careers working with plants - launched its first campaign in April 2018 focused on middle-schoolers. In partnership with Scholastic, BLOOM! utilizes eye-catching, fact-based content delivered both inside and outside of the classroom. In the first year, almost one million 6th-8th graders were reached with the program. (http://www.scholastic.com/BLOOM). In early 2019, we launched our new career exploration tool highlighting almost 100 careers in the horticulture industry (https://www.seedyourfuture.org/careers). In 2019, SYF will continue and expand the middle-school program, with a goal to reach 1.5 million more students. We also are launching our next audience campaign - colleges and universities. With that goal in mind, Seed Your Future is hosting a national summit of the two and four-year college and university horticulture program leaders and student recruiters in June 2019. Leaders will share student recruitment promising practices and success stories. Attendees will have an opportunity to engage and interact with industry leaders to understand what skills and experience they need from students graduating from 2- and 4-year college and university horticulture programs. The oral presentation will provide more detail on the BLOOM! movement and will provide ideas for using SYF materials in college and university recruiting efforts. (https://www.SeedYourFuture.org)

- SYF Logo R Semi Cropped.JPG (15.0KB)

Specified Source(s) of Funding: Seed Your Future

4:30 PM – 4:45 PM

Citizen Science - Improving Critical Thinking Skills

Linda Chalker-Scott*, Washington State University

The increase in unfiltered information available on the web has created a need for university Extension programs to assist its state citizens in developing critical evaluation skills. This is particularly important for individuals involved in garden-, nursery-, and landscape-related professions or avocations, where anecdotal information and aggressive product marketing can adversely influence decision making. This presentation will introduce participants to a free, peer-reviewed WSU Extension Manual (http://cru.cahe.wsu.edu/CEPublications/EM100E/EM100E.pdf) on scientific literacy that could be used for Master Gardener training, professional workshops, and other public education venues.

4:45 PM – 5:00 PM

Building Scientific and Organizational Capacity Along the Horticulture Value Chain By Engaging International Partners and Young Scientists

Lauren L. Howe*, Horticulture Innovation Lab at the University of California, Davis

The Trellis Fund is a grant making and capacity building initiative within the Horticulture Innovation Lab. Trellis connects organizations in lower-income countries with U.S. graduate students from Horticulture Innovation Lab partner institutions who have agricultural expertise, generating benefits for both the students and the in-country institutions. Together, they collaborate on short-term projects to address horticultural challenges faced by local farmers. Selected organizations each receive small grants for a variety of projects along the horticulture value chain, including production, postharvest, marketing, and consumption, that will help smallholder farmers improve how they grow or sell fruit and vegetable crops. The Trellis Fund aims to empower smallholder farmers with new information as well as build long standing relationships between host organizations and budding U.S. researchers.

The Trellis Fund program objectives are related to: providing organizational capacity building for local organizations working on issues along the horticultural value chain; promoting the technical extension capacity of local organizations working on horticulture to provide scientifically valid information to their beneficiaries; providing scientifically valid extension information to local smallholder farmers and/or other horticultural stakeholders; and engaging U.S. graduate students in international agricultural development. Trellis has demonstrated how young scientists can meaningfully contribute to and collaborate around the goals, development and capacity of small organizations abroad. Graduate students have benefited from Trellis in terms of career development, and local organizations have been able to more effectively deliver evidence-based extension information to producers. Another unique facet of the Trellis Fund is that it is a program completely designed, implemented, and evaluated by graduate students at the University of California, Davis.

Trellis has been in existence since 2011 and over six rounds, it has funded 76 local organizations, engaged 77 U.S. graduate students, and trained almost 12,000 individuals (over ⅔ women). The program structure and history, key successes and challenges, and goals for the future will be shared. We believe in the Trellis model and have seen its impact on both organizations and graduate students. Trellis was designed to be easily duplicated by other universities and organizations and could be scaled up or down. Eager to see the model spread so that more graduate students and organizations get the opportunity to collaborate on projects, information on how other institutions could leverage their own horticultural resources, partnerships, and expertise to implement a program similar to Trellis will also be discussed.

Specified Source(s) of Funding: USAID

Ecological Physiology 1

Moderator: Kaan Kurtural
University of California, Davis, CA, USA

An asterisk (*) in front of a name indicates the presenting author.

3:30 PM – 3:45 PM

Freezing Survival Strategy in Cranberry (*Vaccinium macrocarpon* Ait.) Terminal Buds

Camilo Villouta*; Beth A Workmaster; Jenny Bolivar-Medina; Smith Sinclair and Amaya Atucha, University of Wisconsin-Madison

Large changes in cranberry bud freezing stress survival occur during the dormant period. However, the timing and exact nature of these changes are not well understood due to the lack of information in physiological processes of dormancy, temperature acclimation and deacclimation, as well as the anatomical changes in and around the terminal bud of the cranberry plant. The objective of this study was to elucidate the freezing stress survival strategy of terminal cranberry buds, and to evaluate specific bud structure responses to freezing stresses for the purpose of developing a standardized methodology to evaluate cold hardiness. Controlled freezing test (CFT), differential thermal analysis (DTA), and histological evaluation of bud structures were performed during fall and early winter. Our findings show that cranberry terminal buds do not generate detectable low temperature exotherms (LTEs). Through the use of a novel methodology of visual evaluation of freezing injury in buds subjected to CFT, we observed a gradual increase in the damage severity of different tissues within the terminal bud as temperatures decreased. The range of damage in bud structures changed as fall progressed, and a distinctive increase in bud cold hardiness was observed in the month of October. Large voids were identified in bud scales in early winter, which are likely the result of ice formation during freezing events. The results of this study suggest that cranberry terminal buds likely withstand periods of freezing stress by extraorgan freezing.

Specified Source(s) of Funding: National Institute of Food and Agriculture, United States Department of Agriculture, Hatch project 1009297 and the Wisconsin Cranberry Research and Education Foundation.

3:45 PM – 4:00 PM

Prediction of Flowering and Fruiting Phenology Using Physiological Days for Winter Strawberry Production in Florida

Dante Pinochet*, Universidad Austral de Chile and Shinsuke Agehara, University of Florida

The best niche market for strawberry production in the U.S. is the winter period from November to February, during which time the grower prices are above the annual average. To take the best advantage of premium prices, it is critical for winter strawberry producers in Florida to predict the impact of weather conditions on seasonal yield distribution. Accurate prediction of phenological events must take into account various climatic conditions, as well as the sensitivity of crop to climate variables. In this study, a model was generated and calibrated to predict flowering and fruiting peaks using information published by Mackenzie and Chandler in 2015 for the 2005-2006 and 2006-2007 production seasons in Florida. To evaluate the phenological events, physiological days (p-days) introduced for potatoes by Sands et al. in 1979 was used. Its concept is similar to degrees-days, but it models a non-linear relationship between temperature and development of the crop, with an optimal value and two limit values of temperature under which and over which there is no phenological development. The thermal limits used in this model were taken from the published literature on the effects of temperature on the flowering and fruiting of strawberries. In the model, both flowering and fruiting were assumed to have three waves. These waves were modeled using a Gaussian function, which estimates the peak of each event (where the mean value is located) and the most probable range of starting or ending of each wave, according to the value of the standard deviation of the mean. Using these intervals, p-days were derived for each event in each season. The estimation of p-days was further modified by considering the effect of cloudiness. For horticultural management purposes, we suggest dividing the phenology development into two phases. The divisive point of phases should be the end of the second wave of fruiting, which in turn was coincident with the peak of the third wave of flowering. The first two fruiting waves would be responsible for the early production of the crop and its variation with the climate would allow us to adjust the planting date and density to maximize early productivity of the crop. The model proposed was validated using independent experimental for strawberry yield data recorded in the same area during the 2016-2017 and 2017-2018 seasons.

Specified Source(s) of Funding: Florida Strawberry Research and Education Foundation

4:00 PM – 4:15 PM

Flavonol Profile of Red Grape (*Vitis vinifera* L.) Berry Is a Reliable Indicator to Assess Their Exposure to Solar Radiation and Study Changes in Their Composition.

Johann Martínez-Lüscher*, University of California Davis; Luca Brillante, California State University Fresno and Kaan Kurtural, University of California

The organoleptic properties of most fruits get great benefit from exposure to solar radiation. In wine grapes, fruit location is highly focalized under the canopy, and thus, trellising, pruning and canopy management practices aim to achieve an adequate fruit density and exposure. The accumulation of flavonols is the most universally reported acclimation response of plant tissues to UV-B radiation. In fact, flavonol synthesis is upregulated by solar radiation leaving a fingerprint on flavonol profile. Over the years, we have collected pieces of information about the factors affecting flavonol accumulation and profile. The aim was to investigate the reliability of flavonol profile as an indicator to assess the overall exposure of red wine grape berry to

solar radiation. We performed three experiments to study the response of flavonol accumulation and profile to (1) three different solar radiation exclusion treatments during berry development; (2) canopy porosity and leaf area index (LAI); and (3) spatial variability of water status, vigor and ripening and cultural practices in commercial vineyards. Results showed a strong relationship between global radiation, inverse dormant pruning weights or canopy porosity (inversely proportional to LAI) and % kaempferol or % quercetin. In addition, the increase in concentration of the above two flavonols was associated with a reduction of % myricetin. Total flavonol content, % kaempferol, % quercetin and % myricetin were not consistently correlated to berry ripening or water deficit. Flavonol profile was associated to site hydrology (wetness index) through changes in vigor, and responded to shoot thinning or fruit-zone leaf removal. Other flavonoids such as anthocyanins, proanthocyanidins and flavan-3-ols were negatively correlated to % kaempferol. In addition, % kaempferol correlated to the maximum temperature of the clusters. The removal of berry 3-Isobutyl-2-methoxypyrazine, an aroma characteristic of bell peppers, was not correlated to a greater exposure. In contrast, soluble solids level were strongly related to 3-Isobutyl-2-methoxypyrazine levels. These results support the reliability of the flavonol profile as an assessment parameter for studies aiming to discuss canopy architecture or the effect of solar radiation on grape berry composition.

Specified Source(s) of Funding: USDA-NIFA Specialty Crop Research Initiative award no. 2015-51181-24393

4:15 PM – 4:30 PM

Grapevine Red Blotch Virus Reduces Carbon Translocation Leading to Impaired Grape Berry Ripening

Kaan Kurtural*, University of California and Johann Martinez-Luscher, University of California Davis

Grapevine red blotch virus (GRBV) is a concern to grape industry reducing vineyard longevity, and it is suspected to alter berry ripening and chemistry. The aim of this study was to perform a physiological characterization of GRBV infected grapevines with special attention to the factors leading to inadequate grape ripening. We performed a two-year field experiment with healthy GRBV-negative (RB(-)) or infected GRBV-positive (RB(+)) *Vitis vinifera* 'Cabernet Sauvignon' grafted on either 110R (*Vitis berlandieri* × *Vitis rupestris*) or 420A (*Vitis berlandieri* × *Vitis riparia*), two rootstocks with different vigor and drought tolerance in Oakville, CA, USA. Leaf sugars were assessed with GC-MS. Grape berry skin flavonoids were measured using RP-HPLC. Grapevines infected with GRBV had reduced carbon fixation and stomatal conductance but only towards the end of the season; paradoxically, this was coupled to a higher stem water potential especially in 110R_RB(+). An increase in leaf soluble sugars was also found in RB(+) grapevines. Although this altered physiology was not observed consistently throughout the whole second season, both years displayed a severe reduction in berry total soluble solids (TSS) accumulation and loss of titratable acidity (TA), but not pH. Maximum anthocyanin accumulation was lower in berries from RB(+) grapevines but the differences were reduced by harvest. Contrarily, proanthocyanidins were higher in 110R_RB(+) sampled on the same date as 110R_RB(-), but not when samples with similar TSS were compared. Further comparisons of berries with the same TSS revealed a significant decoupling of must pH and anthocyanin content, but not TA, from TSS accumulation. The strong reduction in carbon import into berries (determined through TSS) under mild and transient reductions in carbon fixation suggested an impairment of translocation mechanisms in diseased vines. This may also have implications for the transport of ripening signals, other than hexoses and sucrose, which may contribute to explain why GRBV not only delayed ripening, but also decoupled ripening processes that are highly orchestrated in healthy vines.

Specified Source(s) of Funding: American Vineyard Foundation

4:30 PM – 4:45 PM

Root Tip Oxidative Stress Is Part of the Blueberry Response to High pH Nutrient Solutions

Gerardo H. Nunez*; Camila I. Arzola; Ashley Turner; Dante Leventini and Moshik Doron, University of Florida

Unlike most horticultural crops, blueberry (*Vaccinium* spp.) thrives in acidic soils (pH 4.2 – 5.5) and is stressed by higher pH soils. While it is well established that high pH stress reduces growth and yield in blueberry, root-level responses to high pH stress are notably absent from our current understanding of this problem. We investigated how high pH stress affects blueberry roots. For this means, we compared root oxidative status between 'Emerald' southern highbush blueberry (*V. corymbosum* L. interspecific hybrids) and *V. arboreum* Marshall genotype FL09-502. These genotypes have been previously characterized as high pH-sensitive ('Emerald') and high pH-tolerant (FL09-502), respectively. One year-old rooted cuttings were transplanted to a hydroponic growth system filled with a complete nutrient solution. After 14 days of acclimation at pH 5.5, plants were exposed to complete nutrient solutions buffered to pH 4.5 or pH 6.5. Relative membrane permeability was measured in fresh root samples. Proline content, lipid peroxidation, catalase and peroxidase activity were measured on root tip samples that were flash frozen and stored at -80 °C. Relative membrane permeability and proline content were not affected by pH treatment. On the other hand, pH treatment affected plant oxidative status. 'Emerald' exhibited significantly higher lipid peroxidation rates at pH 6.5 than at pH 4.5, while lipid peroxidation in FL09-502 was not affected. These results suggest that oxidative stress might play a role in *Vaccinium* spp. decline or resilience in high pH soils. This advances our understanding of high pH stress responses in

An asterisk (*) in front of a name indicates the presenting author.

this genus and provides a biological marker that can be used to identify additional high-pH tolerant genotypes.

Specified Source(s) of Funding: This research was supported by the Thad Cochran Southern Horticultural Laboratory, U. S. Department of Agriculture Agricultural Research Service under NACA agreement number 58–6062–5-005.

4:45 PM – 5:00 PM

Light Quality and Night Interruption Controls Morphogenesis and Flowering Time in Day Neutral Strawberry.

Varinder Sidhu*; Valerie Gravel; Suha Jabaji and Mamta Rani, McGill University

Light quality, referring to wavelength and photoperiod are the key factors regulating strawberry flowering time, phenological growth and consequently, fruit production. Night interruption (NI) is a treatment providing by artificial lighting during the dark night period to simulate LD photoperiodic conditions. While the light quality and photoperiodic control of flowering has been extensively studied in short day (SD) strawberry cultivars, little is known about the flowering behavior of day neutral (DN) strawberries, despite their rising popularity within the industry. The main objective of this study is to determine the effect of light quality and NI on flower bud induction of DN strawberry. As a first step, we investigated the effect of light quality on flower bud induction (FBI), morphogenesis and transcription of flowering genes intransplants of woodland strawberry (*Fragaria vesca* cv 'Alexendria'). Plants were grown under far-red (760nm) and blue (450nm) light emitting diodes (LEDs) at a ratio of 5:1 and 1:5, supplied with long-day (LD) photoperiod (16h light/8h dark) in controlled environment. LD photoperiod supplemented with higher blue light resulted in a significant ($p<0.05$) increase in leaf growth and flower bud induction compared to far-red light during transplant production. Additionally, it was observed that flowering time, morphogenesis and expression of FLOWERING LOCUS (*FvFT1*)/ SUPPRESSOR OF THE OVEREXPRESSION OF CONSTANS (*FvSOC1*) can be stimulated by blue light quality. As a second step, seedlings were exposed to photoperiods of 10h (SD), 15h (LD), 10h (8h+2NI) and 15h (13h+2NI) using fluorescent lights in growth chambers under controlled conditions (25/20°C and 70% RH). Plants treated with 13h+2NI significantly induced flower bud differentiation compared to 8h+2NI. However, there was no significant difference between 10h SD and 15h LD treatments or in vegetative growth (i.e. runner and leaf count) for all treatments. The study implies that flowering in DN strawberry can be accelerated by an increased ratio of blue to far-red light supplemented during night interruption. Furthermore, NI in combination with blue light could be a successful practice to regulate flowering time during transplant production.

Specified Source(s) of Funding: NSERC and Onesime Pouliot farm

Tuesday, July 23, 2019

Floriculture 1

Moderator: Emily S. Teng
University of Hawaii at Manoa, Honolulu, HI, USA

8:00 AM – 8:15 AM

Micropropagation of *Anthurium Andraeanum* Hort. 'New Pahoa Red' Using Recipient for Automated Temporary Immersion (RITA)

Jaclyn Nicole R Uy*, University of Hawaii and Teresita D. Amore, University of Hawaiʻi at Mānoa

Current commercial production of anthurium in Hawaii is limited by the availability of micropropagated planting material. *Anthurium andraenum* Hort. 'New Pahoa Red' is the most widely-grown cultivar in Hawaii and propagules for this variety are in great demand by commercial growers. Conventional micropropagation of anthurium includes multiplication of axillary buds in liquid culture. The use of semi-automated systems such as temporary immersion systems has been adopted for commercial micropropagation in a number of crops due to its ease of use, ability to produce high numbers of micro-plantlets and bypass physiological disorders caused by submerged culture. This study aimed to develop a protocol for anthurium micropropagation using the Recipient for Automated Temporary Immersion (RITA) bioreactor. Nodal segments (two axillary buds per explant) were excised from *in vitro* 'New Pahoa Red' microplants and cultured in medium under RITA or in 125 mL Erlenmyer flasks using modified Kunisaki (1982) medium. After 6 weeks of culture, explants in the RITA bioreactor produced 25 shoots per vessel compared to 6.2 shoots from the standard method. Likewise, a higher percentage of explants with induced shoots was also observed in the RITA system (85%) compared to the standard vessel (21%). In a second experiment to optimize immersion parameters for the RITA bioreactors, nodal explants were subjected to various combinations of immersion time (0, 5, 10, 20 minutes) and volume (10 or 20 ml) of medium per explant. The average number of shoots induced per explant was not affected by the volume of media provided per explant, although immersion time was highly significant. The highest average number of shoots induced per explant was observed under with 10 minutes immersion, which produced an average of 2 shoots per explant. Interaction effects of immersion and medium volume were highly significant for average number of shoots per vessel unit and percentage of explants forming shoots. Ten minutes immersion and 20 ml per explant produced the highest average number of shoots (20.3) produced per vessel unit and the highest percentage of explants forming shoots (96.6%). Inclusion of RITA can supplement and increase the production of anthurium micropropagules.

Specified Source(s) of Funding: USDA-NIFA Hatch Project 868H

8:15 AM – 8:30 AM

Physiological Bases for Differential Growth Responses to Supplied Nitrogen Concentration in Poinsettia Cultivars

Ranjeeta Adhikari* and Krishna Nemali, Purdue University

Responses among cultivars within a species to supplied N can vary drastically. Limited research exists on the physiological mechanisms associated with growth differences to supplied N among different cultivars within a species. This is useful for developing fundamental knowledge on plant-N responses, new cultivars and fertilizer guidelines. Two experiments were conducted using poinsettia (*Euphorbia pulcherrima*) cultivars in a greenhouse. In the first experiment, four cultivars were evaluated for differential N responses under optimal (375 ppm N) and sub-optimal (112.5 ppm N) fertilizer treatments. Two cultivars, i.e., Christmas Glory White (CGW) and Christmas Tradition (CT), were selected for further testing based on their growth differences to supplied N in experiment I. Shoot dry weight (SDW) was significantly higher in CT than CGW under optimal treatment whereas it was not different between cultivars under sub-optimal treatment. There were no differences in root dry weight (RDW), root weight ratio and tissue N content between cultivars in both treatments. To further understand the physiological bases for differential responses, we conducted a second experiment in which we measured SDW, leaf area (LA), leaf photosynthesis (A) and chlorophyll fluorescence responses to photosynthetic photon flux density (*PPFD*) and chlorophyll concentration (CC). Statistical analysis confirmed that SDW responses between two cultivars were similar in both experiments. Relative decrease in SDW and LA between sub-optimal and optimal treatment were significantly higher for CT than those of CGW. This indicated that CGW performed better than CT under sub-optimal compared to optimal treatment. These responses were not likely associated with differences in N uptake in the sub-optimal treatment as there were no differences in root growth and tissue N (based on experiment I). In addition, there were no differences in spectrophotometer based chlorophyll content indicating no differences in N partitioning to chlorophyll between cultivars. *A-PPFD* analysis indicated that light saturated photosynthesis (A_{max}) was higher in CT than CGW under optimal but it was not different under sub-optimal treatment. Observed differences in A_{max} may indicate a relatively higher RuBisCO content in CT than CGW under optimal and no differences in RuBisCO between cultivars under sub-optimal N conditions. Based on these results, we conclude that observed differential shoot growth responses between CGW and CT under sub-optimal treatment are likely associated with differences in N partitioning to RuBisCO between cultivars.

8:30 AM – 8:45 AM

Bacterial Number and Pulsing Time Affect Postharvest Quality of Cut Lilies

Yen-Hua Chen* and William B. Miller, Cornell University

Water is extremely important for maintaining postharvest quality of cut flowers. Lily grower have questioned the need to maintain careful sanitation on the idea lilies are less susceptible to “dirty water” than other flowers, e.g. gerbera. We hypothesized that lily stems held in water with increasing population of bacteria would have reduced water uptake and postharvest performance. *Lilium* ‘Sorbonne’ stems were harvested 1-2 days before the first flower opened then exposed to different populations of bacteria (0 to 2 x 10^7 CFU/ml) in the vase solution. The average individual flower life was negatively related to the initial population of bacteria. Moreover, flower diameter was greater in control versus other bacterial water (BW) treated stems. When bacteria population was greater than 10^6 CFU/ml, water uptake and flower life were reduced dramatically. To investigate the duration of exposure to BW, stems were exposed to 2 x 10^7 CFU/ml bacterial water for 1, 2, or 3 days, then placed into clean water, or were held in BW continuously. By 24 h, BW reduced total water uptake by 43% compared to controls. The longer the exposure time in BW, the less water uptake. Flower diameter and individual flower life were both significantly reduced when the exposure time in the BW increased. Taken together, the data show increasing bacterial population and exposure time reduce water uptake, flower diameter and flower life. Growers who wish to reduce costs associated with sanitation procedures would be well advised to carefully wash buckets and maintain cleanliness to maximize lily postharvest quality.

8:45 AM – 9:00 AM

Identification and Quantification of Anthocyanidins in Modern Poinsettia Cultivars Using High Performance Liquid Chromatography (HPLC)

Emily S. Teng*[1]; Jon-Paul Bingham[1] and Teresita D. Amore[2], (1)University of Hawaii at Manoa, (2)University of Hawai‘i at Mānoa

Every holiday season, consumers are attracted to the eye-catching bracts of poinsettias (*Euphorbia pulcherrima* Willd. ex Klotzsch*)*, the most popular holiday potted plant. Anthocyanin pigments produce the red and pink colors of poinsettia bracts. Pigment profiles of modern poinsettia cultivars are lacking as identification and measurement of anthocyanins in poinsettia cultivars has not been conducted since the 1980’s. High Performance Liquid Chromatography (HPLC) is the standard method for anthocyanin identification and quantification. Methods for extracting and analyzing anthocyanins in pitanga fruit using HPLC were adapted for poinsettia bracts. Pigments were extracted using an acidic methanol solution, separated from other flavonoids using a C18 porous matrix cartridge (Waters™), then separated from sugars using acid hydrolysis. HPLC analysis was conducted using a Waters™ Alliance 2695 Separations Module with a Waters™ 996 Photodiode Array Detector. Separation of anthocyanidins was accomplished with an XBridge™

Peptide XB-C18 column. Separating the sugars leaves the anthocyanidin aglycones, simplifying identification and allowing for accurate quantification of total anthocyanin content using external standards. This protocol produced rapid and optimal HPLC chromatograms with high peak symmetry and excellent baseline resolution. Identification and quantification of the anthocyanidins and total anthocyanin content in a range of colors of modern poinsettia cultivars was performed using this protocol. Cyanidins occur in the greatest concentration, followed by pelargonidins. Total anthocyanin content was highest in red cultivars, followed by pink cultivars. White cultivars contained the least amounts of anthocyanins. Anthocyanin profiles of modern commercial poinsettia cultivars will be useful to poinsettia breeders tasked with creating new and improved cultivars for the industry. Characterization of current germplasm and new hybrids will help breeders make hybridization decisions and evaluate commercial viability of new hybrids.

Specified Source(s) of Funding: Monsanto Graduate Fellowship

9:00 AM – 9:15 AM

Functional Analysis of Nutrient Mobilization-Related Genes in Petunia Petal Senescence

Yiyun Lin*, The Ohio State University

Flower longevity is an important characteristic of floriculture crops. When petals senesce, ornamental plants lose their aesthetic and economic value. However, the regulatory mechanisms involved in flower petal senescence are complex and not well understood. Although nutrient mobilization is considered important in the regulation of flower petal senescence, there is a lack of genetic evidence to substantiate the roles of nutrient mobilization-related genes during this process. A recent transcriptomic study of *Petunia × hybrida* corollas identified nutrient mobilization-related autophagy (*ATG*) and nuclease (*NUC*) genes that are differentially regulated during petal senescence. We hypothesize that regulating the expression levels of these genes will affect the longevity of petunia flowers, with varying effects under high and low nutrient conditions. To test this hypothesis, individual genes were knocked down using virus-induced gene silencing (VIGS) in *Petunia × hybrida* 'Picobella Blue'. The *ATG*-silenced plants were fertilized with 50 or 250 ppm N from 15-5-15 fertilizer at every irrigation, and the *NUC*-silenced plants were given nutrient solutions with normal or low phosphate levels. Our results indicate that the silencing of *NUC1*resulted in delayed flowering and early senescence, and the silencing of three individual *ATGs*-caused changes in flowering time, flower longevity, and flower number in petunia under different fertility levels. The genes identified in this study will be further tested using stable genetic engineering and genome editing. The results of this project will be fundamental for future studies of flower petal senescence and will provide genetic information for future floriculture crop improvement.

Specified Source(s) of Funding: D. C. Kiplinger Endowment Fund, The American Floral Endowment

9:15 AM – 9:30 AM

Evaluation of Asclepias Spp. Hybrids for the Creation of Novel Cultivars

Mary Lewis* and Matthew Chappell, University of Georgia

Landscape plants that attract pollinators are becoming more popular as concerns over pollinator health resonate with consumers. *Asclepias* is an important ecologic host and food source for many butterfly species that utilize nectar and foliage as food sources. It is also known for its attractive floral structures and performance in landscape environments with minimal fertilizer and irrigation inputs. Despite having ornamental and ecologically valuable traits, cultivars of *Asclepias* spp. are not commonly found in the ornamental market as *Asclepias* spp. does not tolerate commercial growing protocols that incorporate high fertility and irrigation rates, and as a result grow to heights too large for efficient racking and shipping or suffer from pathogens. This study utilized nine species of *Asclepias* as pollen donors, hybridized with *Asclepias tuberosa* (maternal parent), with the goal of obtaining hybrid progeny with improved phenotypic characteristics and environmental tolerances. Pollen parents included *A. speciosa* Torr., *A. syriaca* L., *A. viridis* Walter, *A. incarnata* L., *A. purpurascens* L., *A. hirtella* Woodson, *A. verticillata* L., *A. curassavica* L and *A. fascicularis* Decne. Yet before attempting to make crosses, controlled pollination techniques needed to be developed, as none were available for *Asclepias* and success is extremely low (>1%) in nature. A method developed in this study inverted *Asclepias* pollinia when making crosses, to optimize contact with the stigmatic surface. Results showed a twelve-fold increase in seed pod (fruit) set (from >1% observed in nature to 11.72%). By using the pollination method developed in this study, successful hybrids were created between *A. tuberosa* and four of the nine species that served as pollen parents. Germination techniques of direct seeding and 30-day cold-moist stratification were also tested when assessing viability of hybrid seed. Hybrid crosses had germination percentages comparable or greater than that of selfed *A. tuberosa* (the maternal parent) when using both seed treatments; however cold moist stratification resulted in higher germination rates. Inheritance of key phenotypic traits will be evaluated, and this information will provide the industry an avenue to increase production and distribution of *Asclepias* to the market.

Fruit Breeding 1

Moderator: Margaret Worthington
University of Arkansas, Fayetteville, AR, USA

8:00 AM – 8:15 AM

Current Progress and Challenges for DNA Marker Development and Application in Strawberry

Breeding

Youngjae Oh[1]; Zhen Fan[1]; Sadikshya Sharma[1]; Yi-Tien Lu[1]; Natalia Salinas[1]; Jason D. Zurn[2]; Sujeet Verma[1]; Nahla Bassil[2]; Vance M Whitaker[1] and Seonghee Lee[*1], (1)University of Florida, (2)USDA-ARS NCGR

The genome of diploid woodland strawberry (*Fragaria vesca*) was first available in 2011, and more recently octoploid reference genome sequence (cv. Camarosa) was published. The first strawberry DNA test was developed for fruity aroma gene, FaFAD1, in cultivated strawberry to enhance fruit flavor. For the last five years, University of Florida strawberry breeding team has identified QTLs for fruit quality and disease resistance, and developed multiple DNA tests for marker-assisted breeding in strawberry. Using our high-throughput DNA test platform, it is now possible to rapidly stack multiple genes for disease resistance and fruit quality into a single cultivar. Thus now, tens of thousands of seedlings can be cheaply and quickly screened using a high-throughput marker-assisted seedling selection, allowing us to "stack the deck" for desirable traits prior to field evaluation. The use of DNA marker technology in strawberry breeding is now being a routine procedure to combine durable disease resistance with high fruit quality. In this presentation, it will be discussed the challenges and solutions to develop highly accurate and efficient DNA markers in a complex polyploid genome. Our technical methods and approaches utilized for strawberry DNA tests will be crucially informative not only for fruit crops but also for other crops with complex genomes.

Specified Source(s) of Funding: RosBREED

8:15 AM – 8:30 AM

Identification of QTLs for Bloom Date, Fruit Development Period, and Ripe Date Traits in Peaches

Zena Rawandoozi[*1]; Timothy P. Hartmann[1]; Ksenija Gasic[2]; Cassia Da Silva Linge[2]; Lichun Cai[3]; Nahla Bassil[4]; Eric van de Weg[5] and David H. Byrne[1], (1)Texas A&M University, (2)Clemson University, (3)Michigan State University, (4) USDA-ARS NCGR, (5)Wageningen University & Research

Phenological traits of peaches [*Prunus persica* (L.) Batsch] are important for breeders to evaluate in various environments for determining cultivar adaptability, and for the grower to efficiently manage their commercial orchards. Pedigree-based analysis (PBA) using Visual FlexQTL software was conducted on 162 peach individuals (143 F_1 seedlings and 19 founders and parents) grown in four environments (CA 2011, CA 2012, TX 2012, and TX 2013). A 9K SNP Illumina array was used for the genotyping. The objectives of this study were to 1) identify QTL(s) of three phenological traits including bloom date (BD), ripe date (RD), and fruit development period (FDP); 2) estimate QTL genotypes for important breeding parents of seven full-sib families; and 3) identify the haplotype alleles that are linked to the predictive SNP marker(s) of desired QTL alleles. The QTL for RD and FDP was co-localized at the central part of LG4 (40 - 44 cM) and explained about 35 % of the phenotypic variance. Three QTLs were discovered for BD. These were found on LG1 (88 – 92 cM), LG4 (48 – 50 cM), and LG7 (40 – 44 cM), explaining between 17-94%, 11-55%, and 11-18% of the phenotypic variance respectively. Haplotype analyses for these QTLs revealed predictive SNP haplotypes of desired QTL alleles along with their original sources among the important breeding parents of seven full-sib families. Our results will help peach breeders in developing new predictive, DNA-based molecular marker tests that can be used routinely in marker-assisted breeding (MAB).

Specified Source(s) of Funding: RosBREED project

8:30 AM – 8:45 AM

Identification of Loci Associated with Fire Blight Resistance/Susceptibility in Apple

Sarah Kostick[*1]; John Norelli[2]; Soon Li Teh[1]; Stijn Vanderzande[1] and Kate Evans[1], (1)Washington State University, (2) USDA-ARS

Most commercial apple cultivars are susceptible to fire blight, a bacterial disease caused by *Erwinia amylovora* that can cause structural damage and tree death. Current management practices are not effective against all disease stages and/or unsustainable. A potential long-term solution is breeding for resistance. Most resistance alleles found at quantitative trait loci (QTLs) associated with fire blight resistance/susceptibility have been identified in genetic backgrounds with poor fruit quality (e.g. *Malus* × *robusta* 5, 'Evereste'). Although introgression of these resistance alleles is possible, improving fruit quality while maintaining resistance would be challenging due to apple's long generation times and self-incompatibility. This study's objective was to identify loci associated with fire blight resistance/susceptibility in a pedigree-connected apple reference germplasm set.

Developed during the USDA-SCRI RosBREED project, the pedigree-connected apple reference germplasm set provides efficient allelic representation of important breeding parents (IBPs) in the three US public apple breeding programs. In this study, 27 IBPs were represented in a planting of 556 individuals planted in triplicate in a randomized complete block design. All seedlings, parents and available progenitors were genotyped using the International RosBREED SNP (single nucleotide polymorphism) Consortium Apple 8K Infinium® array.

Using the cut-leaf method, multiple actively growing shoots per tree were inoculated with *E. amylovora* 153n in 2016 ($5×10^8$CFU mL^{-1}) and 2017 ($1×10^9$CFU mL^{-1}). For each inoculated shoot, the response to *E. amylovora* was quantified as proportion of current season's shoot length that was blighted (SLB), calculated from shoot and lesion length measurements. Best linear unbiased predictors (BLUPs), adjusted by

An asterisk (*) in front of a name indicates the presenting author.

the overall SLB mean, were estimated for seedling effects within and across years. Adjusted BLUPs were used as phenotypic values in QTL analyses, which were done using FlexQTL™ software.

Wide variation in fire blight resistance/susceptibility was observed among seedlings in both years, with responses ranging from highly susceptible to highly resistant; adjusted BLUPs ranged from 0.04 to 0.97 SLB. Most seedlings demonstrated similar levels of resistance/susceptibility in both years with a correlation of $\rho = 0.75$ (*p-value* $<1 \times 10^{-4}$) between years for adjusted BLUPs. Putative QTLs associated with fire blight resistance/susceptibility were identified on chromosomes 6, 7, 8, and 15 in both years, which combined accounted for approximately 42% of phenotypic variation. The loci associated with fire blight resistance/susceptibility identified in this study may enable development of DNA tests, which will aid in more efficient pyramiding of disease resistance/susceptibility alleles and development of high-quality cultivars with lower fire blight susceptibility.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission; USDA-NIFA; USDA-NIFA-SCRI RosBREED

8:45 AM – 9:00 AM

Developing Genomics Tools to Support a *Vanilla* Breeding Program in Florida

Alan H Chambers*[1]; Elias Bassil[1]; Maria Brym[2]; Ying Hu[2]; Marcio Resende[2] and Aureliano Bombarely[3], (1)University of Florida TREC, (2)University of Florida, (3)Virginia Tech

Demand for all-natural vanilla flavor is increasing, but its botanical source, *Vanilla planifolia*, faces critical challenges arising from a narrow germplasm base and supply limitations. Genomic tools are the key to overcoming these limitations by enabling advanced genetics and plant breeding for new cultivars with improved yield and quality. *Vanilla* has been cultivated in the United States since the early 1900s. An original *V. planifolia* introduction into Puerto Rico in the early 1900's from Mexico was followed by another introduction from Florida in 1909. The Puerto Rico *Vanilla* industry grew until the 1950s when it quickly declined, though material from the former plantings are still cultivated by growers and hobbyists. *Vanilla* cultivation in Hawaii started with introductions from Mexico, Tahiti, Samoa, and Fiji before 1900, and is mostly focused on the tourism industry today. Commercial production of *V. planifolia* in southern Florida is still being established as a new, high-value industry. Florida, Puerto Rico, and Hawaii all have naturalized *V. planifolia*, and Florida and Puerto Rico have a number of native *Vanilla* species. The establishment of modern *Vanilla* breeding programs could leverage increasingly accessible technologies including advances in genomics and biotechnology to rapidly improve this species for high priority traits like disease resistance, total bean yield, pod uniformity, vigor, non-splitting pods, flower longevity, extract quality, and flowers that are able to self-pollinate without manual intervention. The objective of this work was to establish the genomic resources needed to facilitate analysis of diversity among *Vanilla* accessions and to provide a resource to analyze other *Vanilla* collections. A *V. planifolia* draft genome was assembled and used to identify 521,732 single nucleotide polymorphism (SNP) markers using Genotyping-By-Sequencing (GBS). The draft genome had an estimated size of 2.40 Gb representing 97% of the estimated genome size. A filtered set of 5,082 SNPs was used to genotype a living collection of 112 *Vanilla* accessions from 23 species including native Florida species. Principal component analysis of the genetic distances, population structure, and the maternally inherited rbcL gene identified putative hybrids, misidentified accessions, significant diversity within *V. planifolia*, and evidence for 12 clusters that separate accessions by species. These results validate the efficiency of genomics-based tools to characterize and identify genetic diversity in *Vanilla* and provide a significant tool for genomics-assisted plant breeding. While plant breeding is generally a long-term prospect, the potential benefits are justified by the increasing demand for premium ingredients like natural vanilla extract. In the future, genetic improvement of this species could result in more resilient cultivars that reduce price volatility and excite modern consumers through innovative solutions applied to *Vanilla*.

Specified Source(s) of Funding: University of Florida Dean for Research

9:00 AM – 9:15 AM

Glutathione S-Transferase: A Candidate Gene for Berry Pigmentation in Muscadine Grapes (*Vitis rotundifolia*)

Aruna V. Varanasi; Margaret Worthington*; Lacy D. Nelson and Autumn Brown, University of Arkansas

Muscadine grapes (*Vitis rotundifolia* Michx.) are a specialty crop cultivated in the southern United States. Muscadines (2n=40) belong to the subgenus *Muscadinia* and are distantly related to 'bunch' grapes of the subgenus *Euvitis* (2n=38), including *V. vinifera*. Muscadines are often processed into juices and wines; however, they have poor color stability during storage. Fruit color in muscadines is determined by anthocyanin accumulation in berry skins. While the candidate genes for berry color in *V. vinifera* map to chromosome 2, the color locus in muscadine was mapped to a 0.8 Mbp region syntenic with chromosome 4 of *V. vinifera* in two mapping populations segregating for berry color. The objective of this research was to identify and characterize the candidate gene for color variation in muscadine berries. Of the 21 predicted genes spanning the 0.8 Mbp locus, glutathione S-transferase (*GST4*) was identified as a likely candidate gene involved in anthocyanin biosynthesis pathway. Other members of the GST family have essential roles in anthocyanin transport and accumulation including *Bz2* in maize, *An9* in petunia, *Fl3* in carnation, and *TT19* in *Arabidopsis*. PCR and KASP genotyping assay identified a single intragenic SNP (C/T) marker corresponding to a proline to leucine171 mutation within the muscadine *GST4* (*VrunGST4*) sequence that differentiated black from bronze muscadines in 64 breeding selections, 32 cultivars, and 320 progeny from the two mapping populations. Anthocyanin profiling on a subset of the progeny with CC (homozygote black), CT (heterozygote black), or TT (homozygote bronze) genotypes indicated no correlation between color and anthocyanin content in black muscadine berries. Furthermore, *VrunGST4* action was found to be completely dominant, and no difference was observed in the anthocyanin content or composition in muscadine berries with CC and CT genotypes. *VrunGST4* had higher expression in the ripe berries compared to unripe berries of black muscadines, unlike in the bronze muscadine. These results suggest that berry pigmentation in muscadines may be regulated by a mechanism distinct from *V. vinifera*. The *VrunGST4* sequence from both black and bronze muscadines was successfully cloned into pET19b vector for expression of the VrunGST4 protein. Further research is in progress to determine differences in the catalytic and/or ligandin activity between the black and bronze VrunGST4 proteins. Work is also in progress using RNA seq to identify other potential candidate genes involved in the diglucoside anthocyanin pathway of muscadine. These findings will have important implications in muscadine breeding programs and the processing industry.

9:15 AM – 9:30 AM

Leveraging Synteny across Rosaceae to Identify Loci Controlling Fruit Sweetness in Blackberry

Jason D. Zurn*[1]; Mandie Driskill[1]; Sook Jung[2]; Dorrie Main[2]; Melinda H. Yin[3]; Melissa Clark[1]; David Chagné[4]; Susan Thomson[4]; Lailiang Cheng[5]; John R. Clark[3]; Margaret Worthington[3]; Chad E. Finn[6] and Nahla Bassil[1], (1) USDA-ARS NCGR, (2)Washington State University, (3) University of Arkansas, (4)The New Zealand Institute for Plant & Food Research Ltd, (5)Cornell University, (6) USDA-ARS HCRU

There is a high consumer demand for sweet blackberries (*Rubus* subgenus *Rubus*). Fruit sugar production in related species is highly influenced by the environment and controlled by many genes, each providing small contributions to the phenotype. Many of the molecular pathways mediating sugar production are conserved across species. Therefore, a synteny-based approach was used to identify candidate genes responsible for sugar production in blackberry. Sugar quantitative trait loci (QTL) were identified from the Genome Database for the Rosaceae (GDR) QTL database for apple (*Malus domestica*), peach (*Prunus persica*), and alpine strawberry (*Fragaria vesca*) and synteny analysis was conducted to find conserved QTLs. Three syntenic QTLs that were conserved in at least two species were recovered. The physical regions for these QTLs were identified in the *F. vesca* v1.1 assembly and predicted genes within this region were annotated with Blast2GO. A total of 26 genes with functions associated with sugar production were extracted. Additionally, 789 sugar-associated genes were extracted from the *M. domestica* v3.0.a1 assembly. A BLAST search of the GDR *Rubus* reference transcriptome using the *Fragaria* and *Malus* genes was conducted. A total of 279 *Rubus* candidate transcripts were identified. Exons were predicted for each transcript using the *Rubus occidentalis* v 2 genome. The exons were separated into 2,122 individual sequences that were sent to Arbor Biosciences to design 9,355 Hyb-Seq baits with a 2X tiling density that covered 99.6% of the targeted regions. The Hyb-Seq baits were used in conjunction with a PacBio sequencing approach to genotype 40 cultivars with high and low sugar content from the University of Arkansas and USDA blackberry breeding programs. A total of 430,167 high quality circular consensus sequences were generated. The reads were mapped to the *R occidentalis* v 3 genome using MiniMap2 and polymorphisms were identified using FreeBayes. Polymorphism-trait associations are being identified for the high and low sugar groups for each breeding program. Future work will focus on developing diagnostic tests to predict sugar phenotypes.

Specified Source(s) of Funding: USDA-NIFA SCRI project 'RosBREED: Combining Disease Resistance and Horticultural Quality in New Rosaceous Cultivars' (2014-51181-22378)

Weed Control & Pest Management 1

Moderator: Chris Marble
University of Florida, Apopka, FL, USA

8:00 AM – 8:15 AM

Horseradish Injury Risks Associated with Dicamba-Tolerant Soybeans

S. Alan Walters*; Karla L. Gage and Ronald F. Krausz, Southern Illinois University

Horseradish is an important specialty crop produced in southwestern Illinois, accounting for approximately half of US production. Since this crop is grown in rotation with agronomic row crops in Illinois, it is susceptible to herbicide injury caused from the movement of dicamba herbicide (3,6-dichloro-2-methoxybenzoic acid) applied in dicamba-tolerant soybeans that are grown nearby. Dicamba is a broad-leaf herbicide, which may injure crops or natural vegetation in close proximity. Therefore, studies were conducted to simulate dicamba drift events to determine resulting horseradish crop injury and root yields, and herbicide residue levels in roots, as well as to determine variety response to ½ and 1x rates of this herbicide. Simulated drift rates of dicamba were shown to not cause horseradish injury or yield reduction, and no dicamba residues were detected in roots. However, horseradish varieties differed in their overall visual injury to the higher ½ and 1x rates of dicamba, ranging from 54 to 81%, and 71 to 92% injury respectively, at 28 days after treatment, with '604' being the least sensitive variety of those evaluated. Horseradish height reduction and foliar necrosis at 28 DAT was also lowest for ‘604’ horseradish compared to other varieties. Dry root weight reduction ranged from 7 to 65% and 54 to 81%, respectively for horseradish varieties at ½ and 1x rates of dicamba. This research indicates that horseradish will tolerate dicamba drift events, resulting in no yield loss, but higher application rates will definitely affect yield, with injury differing among horseradish varieties.

8:15 AM – 8:30 AM

A Comprehensive Herbicide Stewardship Program at the University of Tennessee

Neil Rhodes*; Larry Steckel; Tom Mueller and David McIntosh, University of Tennessee

Because of frequent off-target movement of auxinic herbicides to sensitive high value crops, we began a comprehensive educational program in 2011 that stresses the importance of proper stewardship with the use of pasture herbicides. Our goals were to reduce the occurrence and impact of off-target damage to sensitive, high value crops; and to create educational materials and other tools to help with the diagnosis of suspected cases of off-target damage. The initial funding was obtained via a grant and continued funding from Philip Morris International. Later, additional funding was obtained from Altria Client Services, Dow AgroSciences, DuPont Crop Protection, and Monsanto. We focused on four crops (tobacco, cotton, tomato and grape) and five herbicides (2,4-D, dicamba, aminopyralid, aminocyclopyrachlor and picloram) for the creation of educational materials and diagnostic tools. These include still images, time lapse videos and fact sheets; and we made them available through our initial website, herbicidestewardship.utk.edu; it became accessible in 2014. Later it was simplified to herbicidestewardship.com. In 2016, 2017, and again in 2018, widespread problems with dicamba drift occurred in the Midsouth on numerous sensitive crops as a result of in-crop applications of the herbicide in dicamba-tolerant cotton and soybean varieties. In 2017 we broadened our website to include additional information directly addressing stewardship of dicamba and 2,4-D tolerant crop technology. Because producers, even with their best efforts, were having difficulty keeping dicamba within target fields, we began active laboratory and field research programs looking for answers. We have actively provided herbicide stewardship training for growers and other applicators, dealers, and Extension Agents for the past 3 years. And, because proper herbicide stewardship will continue to be even more critical going forward we have incorporated herbicide stewardship training into our undergraduate and graduate curricula.

8:30 AM – 8:45 AM

Investment Returns for Pre-Emergence Herbicide Use in No-till Pumpkin Production

S. Alan Walters*, Southern Illinois University

Many pumpkins in the Midwest are grown using conservation tillage practices, with no-tillage and strip-tillage systems most often utilized. The implementation of conservation tillage systems by pumpkin growers has been somewhat limited due to the lack of effective weed control options, since tillage is widely used in conventional tillage systems for weed control prior to vining. Although weed control is improved with cover crop residues, season-long weed control is difficult to achieve in pumpkin conservation tillage systems due to the lack of sufficient herbicides to provide adequate control. A pre-emergence herbicide evaluation was conducted in no-tillage during 2009 and 2010 using only those specifically labeled for pumpkins to determine the benefits associated with specific herbicide combinations and the return on investment associated with their use. The recommended herbicides and rates (g $ai{\cdot}ha^{-1}$) used were: clomazone (350) + ethalfluralin (1,120); halosulfuron (35); and metalochlor (1,356). The primary weed species present were common waterhemp (*Amaranthus rudis*), redroot pigweed (*A. retroflexus*), giant foxtail (*Setaria faberi*), and large crabgrass (*Digitaria sanguinalis*). Results over both growing seasons indicated that metalochlor applied in combination with clomazone + ethalfluralin provided an increased return on investment compared to other pre-emergence treatments evaluated, which included metalochlor alone and in combination with halosulfuron, as well as clomazone + ethalfluralin alone and in combination with halosulfuron. Those with the lowest return on investment were metalochlor combined with halosulfuron and clomazone + ethalfluralin combined with halosulfuron. Besides providing the highest returns on investment, the pre-emergence application of metalochlor with clomazone + ethalfluralin also tended to produce the pumpkin fruit with the greatest size and diameter under the weed species present.

8:45 AM – 9:00 AM

Herbicidal Control of the Aquatic Invaders Feathered Mosquitofern and Redroot Floater

Lyn A Gettys*; Kyle L Thayer; Ian J Markovich; Joseph W Sigmon and Mohsen Tootoonchi, University of Florida Ft Lauderdale Research and Education Center

Florida’s waters are routinely invaded by new exotic plants. Two new invaders are redroot floater (*Phyllanthus fluitans*) and feathered mosquitofern (*Azolla pinnata*). Redroot floater, a dicot, was first reported in a Desoto County canal attached to the Peace River in 2010. Feathered mosquitofern, a true fern, was first collected in Florida’s waters in Palm Beach County in 2007. Despite their very different botanical classifications, both species can survive out of the water on damp soil, form floating dense mats and cause ecosystem harm by attenuating light and oxygen in the water column. They also interfere with boating, fishing and swimming. Current distribution of both species is primarily southern Florida, but range expansion is likely, so it is critical to identify control methods for these species. We evaluated efficacy of 35 foliar herbicide treatments (single aquatic herbicides or combinations of two herbicides) in greenhouse trials with four replicates per treatment. We applied treatments to robust populations of plants in 68L mesocosms and monitored them for 6 weeks after treatment, then recorded percent coverage and conducted a destructive harvest. Dried plant material was weighed to determine reduction in biomass compared to untreated controls (UTC). Twenty-nine of the 35 treatments reduced biomass and coverage of these species by 90% compared to UTC. Exceptions were 7.7 or 3.9 oz/acre fluridone, 8 oz/acre topramezone, 48 oz/acre glyphosate, and 8.6 or 13.5 oz/acre carfentrazone.

Specified Source(s) of Funding: Florida Fish and Wildlife Conservation Commission Invasive Plant Management Section

9:00 AM – 9:15 AM

Automated Identification of Systemic Fluorescent Markers in Vegetable Seedling Leaves for Weed and Crop Differentiation

Wen-Hao Su*; Steven A. Fennimore and David C. Slaughter, University of California, Davis

Crop and weed differentiation is a major limitation to automation of weed removal. Vegetable crops are very susceptible to damage from early season weed competition. Herbicides used in vegetable crops provide partial weed control, however weed management programs in vegetable crops generally cannot depend on herbicides alone. While some progress has been made towards the development of commercial robotic weed control machines, the majority of vegetable producers still depend upon hand weeding for weed control, a major cost component in the system, indicating that the existing cultivator (whether robotic or conventional) and herbicide technologies are not adequate for the task.

The objective of this study was to establish an effective computer vision method to rapidly differentiate crops from weeds using a systemic marker, Rhodamine B, present in vegetable crop seedlings as a machine-readable identification trait. The seedlings were germinated first. After germination, the roots of these plants were irrigated with Rhodamine dye solution that was detectable in the crop leaves. A novel computer vision system was designed with a custom illumination system designed specifically to excite the fluorescence properties of Rhodamine B and to image them. Rhodamine B was selected for study because it can be used as a fluorescent tracer, has good systemic properties in plants, and is included on the USA EPA List 4B of inert pesticide ingredients “for which EPA has sufficient information to reasonably conclude that the current use pattern in pesticide products will not adversely affect public health or the environment.” and has been used as a tracer in drinking water and for many biological applications. Study results show that the system can detect and allow visualization of the Rhodamine dye internal to the crop system in crop leaves. The research demonstrates that a Crop Signaling approach, using Rhodamine B can be used by a computer vision system to automatically discriminate weeds from vegetable seedlings such as snap bean and tomato.

9:15 AM – 9:30 AM

Limiting Weed Growth in Container Ornamentals through Strategic Fertilizer Placement

Chris Marble*[1]; Debalina Saha[2]; Cody Stewart[2] and Annette Chandler[3], (1)University of Florida, (2)University of Florida - Mid Florida Research and Education Center, (3)University of Florida/IFAS Mid-Florida Research and Education Center

Many ornamental plants are notoriously sensitive to preemergence herbicide applications, which creates challenges for growers who must keep their crops weed free. Beginning in 2016, a series of experiments have been conducted at the University of Florida Mid-Florida Research and Education Center in Apopka, FL to determine effective methods of weed management through strategic fertilizer placement. Four placements including topdressing, incorporating, subdressing, and dibbling were evaluated using a controlled release fertilizer applied at the recommended rate to determine how placement influenced growth and reproduction of large crabgrass (*Digitaria sanguinalis*), spotted spurge (*Euphorbia maculata*) and eclipta (*Eclipta prostrata*) in greenhouse experiments. A similar study was conducted to determine how these different fertilizer placements applied at two rates (low and high recommended rates) influenced efficacy of preemergence herbicides including dimethenamid-P (for spotted spurge control), flumioxazin (for eclipta control), and prodiamine (for large crabgrass control). The greatest shoot and root weights were recorded for all three weed species when fertilizers were either topdressed or incorporated. Dibbling or subdressing fertilizers at a depth of 5 cm resulted in limited to weed growth or seed production and weeds fertilized using these alternative methods were similar to size to weeds that received no fertilizer. When two fertility rates were evaluated, weed growth increased at higher fertility rates in topdressed and incorporated treatments but fertilizer rate did not influence growth of spotted spurge or large crabgrass when fertilizers were topdressed. Fertilizer placement had little effect on preemergence herbicide performance, indicating that weed control efficacy should be consistent across different fertilizer placements. Overall, subdressing fertilizers could be an effective method of weed control in container grown nursery crops. Dibbling resulted in similar or less weed growth than subdressing, but may be associated with crop phytotoxicity in some cases based on previous reports. When using preemergence herbicides, control will likely be influenced by herbicidal active ingredient, rate, and application practices to a greater degree than fertilizer placement.

Specified Source(s) of Funding: Horticulture Research Institute

An asterisk (*) in front of a name indicates the presenting author.

Consumer Horticulture and Master Gardeners

Moderator: Kenneth Thomas Gioeli
UF/IFAS, Fort Pierce, FL, USA

8:00 AM – 8:15 AM

Online Non-Credit Plant ID Classes: A Valuable Partnership with Longwood Gardens

Christine M. Bradish and Lucy K. Bradley*, North Carolina State University

In partnership with Longwood Gardens, we offer three distance education classes on Plant Identification. Each class focuses on a different group of plants: Edibles, Bulbs and Houseplants; Annuals, Perennials, Vines, and Groundcovers; and Trees, Shrubs, and Conifers. The classes are proctored for six weeks and students have access to the site for an additional six months. Each class is broken into 3 segments with each segment containing a video introduction to the material, additional information including vocabulary, plant profiles, and a pronunciation guide; activities, including flashcards, drag and drop exercises and vocabulary games; assignments including forums to post photographs, and vocabulary exercises; and plant identification and plant cultivation quizzes. There is an optional final exam.

Many of the quizzes and most of the final are graded online, the rest, as well as the weekly homework assignments, are hand graded.

The course is offered through the Moodle platform and both NC State and Longwood Gardens provide content and marketing for the program. Enrollment is increasing over time. The fee is $195 for the public $98 for Extension Volunteers, and $50 for Extension professionals.

8:15 AM – 8:30 AM

Reinventing a Consumer Plant Database

Kathleen Moore, North Carolina State University and Lucy K. Bradley*, North Carolina State University

The most important decision a gardener makes is selecting the right plant for the right place. We have transformed the NC Extension Gardener plant database into a powerful, multifaceted tool to guide consumers in making this critical decision. NC State Extension granted $104,000 to the NC Extension Gardener program to transform the plant database (http://plants.ces.ncsu.edu) into a world-class resource. Based on the evaluation of plant databases around the world; surveys of Extension agents, Extension Master Gardener volunteers and plant database users; and focus groups, we created an innovative tool for gardeners, Extension Master Gardener volunteers, extension staff, landscape professionals, university staff, and students. We now capture three times more data points per plant record, add high-resolution photos that document seasons, life cycles, plant parts as well as plant use in the landscape, and have expanded the search capability. While the funding covered software, staff, and IT support to create the expanded structure of the database, it would not have been possible to populate the new fields, upload the thousands of photographs, and update the 3,200 existing records without the invaluable support of Extension Master Gardener volunteers, undergraduate and graduate students, and extension agents and specialists.

Based on input from users, a gallery was created of photographs and landscape designs, each illustrating solutions to common challenges (small spaces, shade, deer resistant, etc.) or inspiring strategies for meeting common goals (children's garden, edible landscape, cottage garden, etc.). A plant list accompanies each entry in the gallery with each plant linked to the profile in the database. In addition, based on years of data on wrong answers on exams, we have added links to plants often confused with the current plant. We have also added IPM information including a link to common insect and disease problems, which are each linked to management strategies. We have included seasonal information and search capacity to help users plan for year-round wildlife habitat, beauty, fragrance, and food production. The database has also been expanded to include recommended varieties of fruit trees and bushes as well as herbs.

Specified Source(s) of Funding: NC State Extension

8:30 AM – 8:45 AM

Horticulture CSI: Search for the Long Beach Radish

Gary R. Bachman*; Christine E. H. Coker and Patricia R. Knight, Mississippi State University Coastal Research and Extension Center

This story of Extension problem solving revolves around the mystery of the disappearance and rediscovery of a radish, the Long Beach Red radish (LBR). Starting in the early 20th century Long Beach, Mississippi was a major player in truck cropping. Many vegetables were grown and shipped, but the primary crop was a radish, known then as the Long Beach Red radish. This radish was so long it looked like a red carrot, about six to seven inches long. Long Beach earned the title of the Radish Capital of the World. In the winter months seeds were sent south for growing and the impressive numbers of harvested LBR, up to 300 railroad boxcars, were shipped up north during the winter months, where they were sliced and set out as bar snacks in northern saloons and beer halls. Other production areas became more favorable and the LBR disappeared. Searching the Mississippi State University Extension records from that time yielded no results. The trail was cold. There were no seed companies advertising LBR seed. By accident a similar radish to the LBR was found, called the Cincinnati Market radish (CMR). Research on this variety revealed it was first bred in the Cincinnati, OH area in the mid-1850s. These seeds were sent south during the winter for shipment back to the north. The disappearance of LBR was the result of using common names. Cincinnati Market Radishes are available from several seed companies. And the first Long Beach Red radishes in 80 years have been grown and promoted across Mississippi by the Mississippi State University Extension Service.

8:45 AM – 9:00 AM

The First-Ever Extension Master Gardener National Strategic Plan

Pamela J. Bennett*, Ohio State University Extension; Natalie Bumgarner, University of Tennessee; R. Michael Maddox, University of Wisconsin-Extension and John C. Orick, Purdue University

The Extension Master Gardener (EMG) program started in the U.S. in 1972. Volunteers are trained through Extension and are required to donate hours of service back to Extension on projects such as garden helplines, backyard garden demonstrations, community gardens and others. Today, there are EMG programs in 50 states and the District of Columbia. However, prior to 2006 there was not a national organization or effort to support the EMG program among states.

The EMG National Committee (EMGNC) was formed in 2006 in order to facilitate national collaboration to avoid redundancy in development of educational training materials for EMGs as well as volunteer management training resources, and expedite collaboration with federal agencies, funders and professional organizations for input and funding for national issues and priorities. As of early 2018, the EMGNC was a fully functioning committee, with updated by-laws, elections of regional representatives, officers, monthly meetings and discussions of key needs for the overall program. A task force was formed in 2016 to look at data collection nationwide and develop a method to capture impact information nationally. In June 2018, several committee members determined that a more formal plan was necessary to move the committee efforts ahead in a planned, strategic manner.

Seven committee members met face-to-face in California in January 2019 and participated in a facilitated strategic planning process. The committee members were from California, Indiana, Iowa, Minnesota, Tennessee, Wisconsin and Wyoming. The meeting took place from Wednesday noon to Friday noon and as a result, the first-ever national strategic plan was developed for the EMG program.

This presentation will be a discussion of the strategic planning process and an introduction to the final strategic plan, as well as the roll-out timeline for the national EMG State and County Coordinators or Program Directors.

9:00 AM – 9:15 AM

Eumaeus Atala Poey (Florida Atala Butterfly) Native Plant Society Field Days in St Lucie County, FL

Kenneth Thomas Gioeli*, UF/IFAS

The Atala butterfly (*Eumaeus atala* Poey) is a beautiful, somewhat rare hairstreak butterfly characterized by satiny black wings featuring an iridescent turquois shimmer. It was thought to be extinct due to overharvest of its host plant, *Zamia integrifolia* Linnaeus. f. These beautiful butterflies are now found on coontie plants in localized colonies primarily in South Florida. In summer 2017 and 2018, Anne Loveridge with the Florida Native Plant Society contacted the UF/IFAS Extension St Lucie County to report a significant abundance of these beautiful butterflies at the Ft. Pierce Inlet State Park. Upon further study, we learned that these butterflies emerge in synchronized patterns enabling us to plan Atala butterfly field days for the Native Plant Society and interested members of the general public. These events attracted media attention and public interest that enabled us to teach people how to identify and conserve these rare butterflies.

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9:15 AM – 9:30 AM

Managing Lead Contaminated Soil in the Home Landscape

Ed Bush*, LSU AgCenter and Grace Ragland, LSU

Soil Pb concentrations can vary widely in native soils throughout the United States. Testing and managing increased soil Pb levels can be a challenge when planting landscapes and gardens. The objective of this research was to develop economically feasible strategies to minimize dust and Pb movement into family gardens. Managing soils with irrigation and raised beds lined with approved geotextiles can reduce upward movement of Pb into gardens. Research showed that proper irrigation, soil stabilization using turfgrass and groundcovers can reduce dust and if desired can be used for phytoremediation. Using introduced soil products that have minimal Pb content is the best choice.

9:30 AM – 9:45 AM

Longwood Gardens Enhanced Professional Horticulture Program

Brian W. Trader* and Sarah Cathcart, Longwood Gardens

The planning for a new program to train gardeners and horticulturists at Longwood Gardens began 50 years ago in 1969. Since that time, Longwood has been administering a two-year program combining hands-on immersive learning with collegiate -level academics. In 2018, as part of the 2022 Strategic Plan, a comprehensive review of Longwood's Professional Gardener Program was conducted. Feedback collected through workshops and surveys with program constituents identified skills, knowledge and experience relevant for current and future horticultural industries. Phone interviews conducted with a cross-section of the horticulture industry provided insight into the needs and expectations of horticultural employers. Feedback from constituents and ideas garnered from benchmarking with peer institutions were used to evolve, improve, and implement program curriculum. The main tenets of the program have been enhanced to inspire learning through immersive academic and practical experiences with an emphasis on practical learning projects. The program will maintain academic rigor and articulate to key universities though a progressive delivery supporting learning and hands-on application in Longwood's gardens. The curriculum has evolved for students to learn weekly, both in the classroom and through working in the gardens. A renewed focus has been placed on the program's individuality, leveraging the expertise of our staff and the legacy of Longwood's Design, Crop Production, and Conservation and Research practices. The redesigned and improved Professional Horticulture Program will provide participants a broad exposure to horticulture through a series of curricular modules while allowing participants the opportunity for focus and personalization.

9:45 AM – 10:00 AM

NC Extension Gardener Handbook: Opening a Kaleidoscope of Opportunities

Lucy K. Bradley*, North Carolina State University and Kathleen Moore, North Carolina State University

What initially began as a simple revision of the NC Master Gardener Manual has morphed into a multifaceted tool that serves as the platform for the entire NC Extension Gardener educational outreach program. This 728-page handbook is the text for programs ranging from Extension Master Gardener volunteers to prison inmates. It includes 1,067 color images, detailed graphics, 109 tables, a glossary and index, case studies, frequently asked questions, and specific management strategies for insects, diseases, weeds, and other pests. Written by a team of horticulture experts, it contains a wealth of information to support gardeners in creating and managing thriving gardens, lawns, and landscapes. It is available free online; as a hardback book for $60.00 and as an eBook for $50.00. The project required the development of a colossal team and benefitted from the contributions of 57 volunteers, 42 agents, and 42 faculty and staff. In 2018, 2,366 hard copies, and 27 eBooks were sold. In addition, 171,802 web users visited the site for a total of 233,363 unique page views.

The handbook inspired the creation of a teacher's guide with all the information that trainers need to "flip the classroom" replacing traditional lectures with hands-on interactive tasks requiring students to organize and use the information helping them own and understand the key concepts at a much deeper level. The Teacher's guide contains: pre-homework, an introductory PowerPoint to run before class while students are assembling, that has a review of the previous session, teasers for current session, and thought-provoking facts, quiz questions and quotes; a PowerPoint presentation and script; supply list, and directions for each interactive station; quiz, homework as well as field trip suggestions. Students are asked to read the chapter ahead of time and come to class for a brief review of key points before rotating through six interactive stations. Each station focuses on a separate objective offering opportunities to experiment, observe, organize and synthesize information through hands-on, role-play, and interactive activities and labs that drive home the objectives of each chapter. The facilitators' guide is full of customizable materials that help instructors easily create a tailored course. This is especially helpful to new agents or those just starting an Extension Master Gardener program in their county as well as public gardens, colleges, nurseries, and prisons that have horticulture training programs and need quality, research-based training materials.

The handbook is also the framework for the expanding Distance Education program

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Specified Source(s) of Funding: NC State Extension

Growth Chambers and Controlled Environments 2

Moderator: Daniel P. Gillespie
The Ohio State University, Columbus, OH, USA

8:00 AM – 8:15 AM

Supplemental Lighting for Biomass Increase of Cilantro and Basil Plants

TC Jayalath* and Marc W. van Iersel, University of Georgia

The positive effects of supplemental red/blue light have been well documented for a variety of greenhouse crops. However, there is a lack of quantitative information to help growers predict the crop biomass gain in response to the amount of supplemental light provided. Therefore, we quantified the biomass increase per mole of photons of supplemental light for two greenhouse-grown herbs. We used red/blue LED lights to provide a wide range of supplemental light (up to 200 μmol m^{-2} s^{-1}) with a red/blue ratio of 75:25. LED Lights were turned on for four hours before sunrise and again after sunset. A treatment with no supplemental lighting was used as the control. Each treatment was replicated ten times. The supplemental photosynthetic photon flux density (PPFD) at each plant was measured using a spectroradiometer. Basil 'Spicy Bush' (*Ocimum basilicum var. minimum*) and cilantro 'Calypso' (*Coriandrum sativum*) were directly seeded in 15 cm pots and placed under the lighting treatments. Plants were spaced 25 cm apart. Basil and cilantro plants were harvested 42 and 60 days after seeding, respectively. The number of photons (mol·m^{-2}) received by each plant from supplemental lighting during the growing period was calculated. We observed significantly greater plant height, chlorophyll content index, and total plant dry weight for both basil and cilantro with supplemental PPFD, compared to the control treatment ($P = 0.005$). Even though we did not see a change in leaf area with the supplemental lighting for either of the herbs, the specific leaf area (leaf area per gram of dry weight) of both basil and cilantro decreased in response to supplemental light (P =

0.034). A regression of shoot biomass versus the amount of supplemental light received showed an increase of 1.06 mg of basil and 0.37 mg of cilantro per mole of supplemental light ($P < 0.0001$), far below the theoretical maximum of 1 g/mol. These values are important for herb growers to determine how much biomass and salable product increase can be expected from supplemental lighting. To maximize the financial return of supplemental lighting, research is needed to maximize the biomass produced in response to supplemental lighting.

Specified Source(s) of Funding: This project was funded by USDA-NIFA-SCRI Award Number #: 2018-51181-28365, project Lighting Approaches to Maximize Profits and by LumiGrow, Inc.

8:15 AM – 8:30 AM

Optimizing Controlled Release Fertilizer for Leafy Greens Grown on International Space Station

Asmaa Morsi*[1]; Gioia D. Massa[2] and Cary A. Mitchell[1], (1) Purdue University, (2)NASA

Astronaut diets on the International Space Station (ISS) depend on resupplied packaged food. However, missions to Mars of 3-5 years will not accommodate re-supply. In addition, many human macro and micro nutrients degrade during long-term storage. Thus, growing nutritional plants aboard ISS is essential for providing astronauts with fresh, healthy produce. NASA is usingan experimental vegetable production unit called VEGGIE to grow fresh salad crops aboard ISS to provide astronauts with healthy diets. VEGGIE is a small plant-growth chamber designed as a garden for astronauts that is low in mass and has a low power requirement. Veggie is equipped with light-emitting diodes (LEDs) but is exposed to the ISS cabin environment. Plants are grown with roots in a baked-ceramic substrate (arcillite) incorporating controlled-release fertilizer and wicks delivering water by capillary action from a reservoir.

The fertilizer capsules release nutrients to plants slowly over time. Different slow-release types have the same amount of fertilizer but release it over different time periods. The Purdue Mitchell lab in collaboration with NASA is testing growth of salad crops within VEGGIE analogs under ISS-like environments in a growth chamber. Specifically, we are evaluating effects of different fertilizer treatmentson "cut-and-come-again" harvest scenarios, comparing productivity and quality of Lettuce as well as anAsian salad crop called Mizuna.

ISS environments being mimicked include temperature: 24/21°C D/N, CO2: 2800 PPM D/N, RH: 45-50% D/N and photoperiod: 16hours.Arcillitemedium contained one of two different fertilizer mixes: 7.5g18-6-8 T 70 + 7.5g 18-6-8 T100, or 7.5g18-6-8 T70 +7.5g 18-6-8 T180fertilizer/liter medium. LED Light treatment provides total PPFD of 330µmol $m^{--2}s^{-1}$ PAR; with 270µmol $m^{--2}s^{-1}$Red(R), 30µmol $m^{--2}s^{-1}$Blue (B), and 30µmol $m^{--2}s^{-1}$Green (G). Plants are grown under those conditions for 8 weeks, and harvested three times at 28, 42, and 56 days from planting. At each harvest, yield parameters as well as tissue mineral content have been measured for optimum fertilizer treatment selection.

Lettuce plants grown underT70+T100 fertilizer treatment had significantly higher yield than those grown underT70+T180 treatment. In addition, lettuce plants grown under both fertilizer treatments had significant increases in yield from harvest to harvest. In contrast to lettuce, first-harvest data for Mizuna indicated that plants grown under the mix of T70+T180 had significantly higher yield than those grown under the mix of T70+T100. The Mizuna experiment is still in progress and data for second and third harvestsas well as mineral composition for all species and treatments will be presented.

Specified Source(s) of Funding: NASA

8:30 AM – 8:45 AM

Lettuce Growth and Morphology Under Different Night-Time Spectral Treatments

Cristian Collado*, North Carolina State University and Ricardo Hernández, NC State University

Previous research in growth chambers showed that spectral changes at the beginning and end of the photoperiod can impact plant growth and morphology. In addition, our previous research showed that lettuce can be grown in long photoperiods (20h+) without a growth penalty. The objective of this project was to improve plant growth through light signals (low light intensity) during the hours without solar radiation. Four-day-old lettuce seedlings of two cultivars, 'Red Sails' and 'Cherokee', were grown in a greenhouse for 16 and 34 days under a 24 h photoperiod. From 0400 to 2000 (16 h) plants were grown under sun light supplemented with (average ± SD) 162.0 ± 3.2 µmol m^{-2} s^{-1} of 15% blue, 3% green, and 82% red (15B:3G:82R) PF ratio. From 2000 to 0400 (8 h) plants were grown under lower PF (24.9 ± 0.3 µmol m^{-2} s^{-1}) of the light signaling treatments; the three light signaling treatments consisted of: 1) 16B:3G:80R (control), 2) 100B, and 3) 100R during 2000-0000 (4 h) followed by 100B during 0000-0400 (4 h) (100R-100B). Photoperiod and spectrum were controlled using the SmartPAR™ system from LumiGrow®. The greenhouse was split in six zones (two repetitions), photosynthetic photo flux (PPF) and temperature were recorded in each zone. After 16 days of treatment, leaf area of 'Red Sails' in 100B was 14% greater than in control and 100R-100B. No differences were detected on fresh mass and dry mass between the three light signaling treatments. After, 34 days of treatment, plant diameter of both cultivars was 6% and 5% greater in 100R-100B than in 100B and control, respectively. However, no differences were detected on leaf area, fresh mass, and dry mass.

8:45 AM – 9:00 AM

Nighttime Supplemental Lighting and Heated Hydroponic Solution Effects on the Growth of Different Lettuce Varieties in Nutrient Film and

Deep Flow Techniques

Alexander Miller*; Petrus Langenhoven and Krishna Nemali, Purdue University

Hydroponic growers typically add supplemental lighting (SL) and heating in greenhouses to grow crops during winter. While studies indicated that spectral composition of SL provided during the day has little effect on crop growth, little research explored differences in spectral composition of SL provided at night. Moreover, comparative studies between conventional methods of heating greenhouse air versus using heated hydroponic solution with cooler greenhouse temperature (HHS) are limited. In addition, the benefit of using HHS and nighttime SL in the nutrient film technique (NFT) and deep flow technique (DFT) systems and for different lettuce cultivars is not known. The objective of this study was to evaluate the interactive effect of nighttime SL with different spectral composition and HHS in NFT and DFT systems on the growth of different lettuce varieties in a greenhouse maintained at suboptimal air temperature. The treatments comprised of three light treatments [no SL (4.2 $mol{\cdot}m^{-2}{\cdot}d^{-1}$), red/blue SL (13 $mol{\cdot}m^{-2}{\cdot}d^{-1}$), and white SL (12.6 $mol{\cdot}m^{-2}{\cdot}d^{-1}$)], each with two solution temperature treatments [unheated (12.6 °C) and heated (18.8 °C)] and further each temperature treatment containing two production systems (NFT and DFT). Red and green cultivars belonging to leaf, romaine, butterhead and oak leaf groups were grown in each production system. The greenhouse air temperature was 15.6/10 °C (day/night). Results indicated a significant light× temperature× production system interaction for shoot fresh and dry weights. Lettuce growth was higher under DFT than NFT and the difference was more pronounced in the heated than unheated treatment in both SL treatments, with larger differences under red/blue LED and heated compared to white LED and heated treatments. However, there were no differences in fresh and dry weights between NFT and DFT in both temperature treatments when SL was not added. In addition, a significant light× production system× variety interaction was observed for shoot fresh and dry weights. There were no differences among varieties in both production systems under white LED and no SL treatments. Whereas, growth of three varieties (Cedar, Red Sails, and Salvius) was significantly higher under DFT than NFT when exposed to red/blue LED supplemental lighting. Based on these results, highest shoot fresh and dry weight of lettuce varieties was observed under red/blue SL given at night with HHS. Moreover, fast growing varieties like Cedar, Red Sails, and Salvius are preferred under red/blue SL and DFT production system.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant and Fluence Bioengineering

9:00 AM – 9:15 AM

Improving Energy Use Efficiency and Nutritive Quality of Lettuce in Indoor Production

Yuyao Kong* and Krishna Nemali, Purdue University

Light emitting diode (LED) lights are preferred in indoor farms due to their low thermal emission, which enables them to be placed close to plants and at multiple levels. In commercial LED lights, broadband light is produced from blue LEDs using 'phosphor conversion' method. A higher proportion of blue light in the total light can be stressful to plants due to excess energy of a blue photon than that is needed for photosynthesis. Lowering blue light fraction and increasing the fraction of lower energy wavelengths (e.g., red light) can increase energy consumption due to increased thermal dissipation by phosphor. Moreover, a higher proportion of blue light can increase carotenoid levels in leaves, a pigment with known health benefits to humans. Our objective was to study the effect of high percentage of red light, blue light and blue light with far-red light in the total light on lettuce growth, energy consumption, energy- use-efficiency (EUE, crop growth per unit energy consumed), crop quality and carotenoid levels in plants. An experiment was conducted using green and red leaf lettuce (*Lactuca sativa* L.) varieties under three LED treatments containing red (R): blue (B): far red (FR) proportions of R_{90}:B_{10}:FR_0, R_{50}:B_{50}:-FR_0, and R_{43}:B_{43}:FR_{14}, each with a total photosynthetic photon flux density of 125 $\mu mol{\cdot}m^{-2}{\cdot}s^{-1}$ under continuous lighting (10.8 $mol{\cdot}m^{-2}{\cdot}d^{-1}$). Results indicated that crop growth and energy consumption were lowest in R_{50}:B_{50}:$FR_{0.}$ However, crop growth significantly increased with far-red addition without differences in energy consumption. Crop growth and energy consumption were highest in R_{90}:B_{10}:FR_0. The presentation will describe bases for observed differences in crop growth, energy consumption, EUE and carotenoid levels among different treatments with recommendations for spectral composition of LED lights for improved EUE and nutritive quality in indoor production.

9:15 AM – 9:30 AM

Thresholds of Hydrogen Peroxide Used for Foliar Spray or Root Applications Under Controlled Environment Plant Production

Mitchell Eicher-Sodo*, Wilfrid Laurier University

Hydrogen peroxide (H_2O_2) is a common oxidizing agent used to disinfect recirculated irrigation water during the production of crops under controlled environmental systems (e.g. greenhouse). Despite this, limited research is available regarding leaf damage caused by foliar spray applications of $H_2O_{2,}$ or the phytotoxic effects exhibited by plants grown in nutrient solutions containing H_2O_2. To characterize phytotoxic effects and define a concentration threshold for H_2O_2, three microgreen species [arugula (*Brassica eruca sativa*), radish (*Raphanus sativus*) and sunflower (*Helianthus annuus* 'Black Oil')], and three lettuce (*Lactuca sativa*) cultivars: 'Othilie', 'Xandra', and 'Rouxai', were foliar sprayed once daily with water containing: 0, 25, 50, 75, 100, 125, 150, or 200 $mg{\cdot}L^{-1}$ of H_2O_2, from seed to harvest under greenhouse conditions. Leaf damage was assessed at harvest using two distinct methods; i) the percentage of damaged leaves per tray and ii) a damage index (DI). Applied H_2O_2 concentrations, starting from 25 mg·L^{-1}, increased the percentage of damaged leaves in every species except 'Black Oil' sunflower, which remained unaffected at any applied concentration. Symptoms of leaf damage, characterized by the DI, manifested in similar patterns on the surface of microgreen cotyledons and lettuce leaves. Establishing a concentration threshold for foliar spray with H_2O_2 required consideration of both metrics, as mean DI values and the percentage of damaged leaves were unique to each crop. Distinctive patterns in leaf damage, at higher H_2O_2 concentrations, allowed for rapid diagnosis of excessive H_2O_2 application. Fresh weights, dry weights and leaf areas, for all crops, were not significantly affected by daily H_2O_2 spray. Based on the aforementioned metrics, maximum recommended concentrations were: 150 mg·L^{-1} (radish), 100 mg·L^{-1} (arugula) for microgreens and 125 mg·L^{-1} ('Othilie'), 75 mg·L^{-1} ('Rouxai') and 125 mg·L^{-1} ('Xandra') lettuce. To evaluate the phytotoxic effects of H_2O_2 in solution culture, one cultivar each of Lettuce (*Lactuca sativa*), Cucumber (*Cucumis sativus*), and Tomato (*Solanum lycopersicum*) are growing in one type of nutrient solution, augmented with eight concentrations of H_2O_2: 0, 25, 50, 75, 100, 200, 300, or 400 mg·L^{-1}. Crops, grown under greenhouse conditions, are constantly exposed to H_2O_2 for a period of 30 days from Feb. to Mar. 2019. Phytotoxic H_2O_2 concentrations are determined using parameters quantifying root quality, plant mortality, and the growth of both roots, and above ground biomass, at each treatment concentration. Analyzed parameter data will be used to establish an upper threshold concentration at which H_2O_2 can be applied in solution culture.

9:30 AM – 9:45 AM

Effects of Light Quality on the Growth and Nutritional Quality of Leafy Greens Under Indoor Controlled Environment

Haijie Dou*[1]; Genhua Niu[2] and Mengmeng Gu[1], (1)Texas A&M University, (2)Texas A&M AgriLife Research Center at El Paso, Texas A&M University

Effects of light quality on the growth and nutritional quality were evaluated on six herbs and leafy greens, including basil (*Ocimum basilicum*) 'Improved Genovese Compact' (green) and 'Red Rubin' (purple), green kale 'Siberian' (*Brassica napus pabularia*), red kale 'Scarlet' (*B. oleracea*), green mustard 'Amara' (*B. carinata*), and red mustard 'Red Giant' (*B. juncea*). Five light quality treatments, including two full spectrum light treatments (white fluorescent lamp, WFL; and white light-emitting diode lamp, WLED) and three combinations of red and blue LED light treatments with different red: blue (R:B) ratios (R:B=1.18, R1B1; R:B=3.44, R3B1; R:B=7.84, R8B1) were applied to plants with the same photosynthetic photon flux density at 224 umol·m^{-2}·s^{-1} with a 16-h photoperiod. All experiments were conducted in a walk-in growth room. Plants were sub-irrigated as needed using a nutrient solution with electrical conductivity of 2.0 dS·m^{-1} and pH of 6.0. The room temperature was maintained at 23.1/20.5ºC day/night. Results indicated that although plant responses to light quality was species dependent, in general, blue light improved plant photosynthesis and nutritional quality while red light stimulated stem elongation and leaf expansion, resulting in increased crop yield. The net photosynthetic rate of purple basil and red kale plants were both the highest under R1B1 treatment, while no difference was observed on the other plant species, but tended to increase with increasing blue light percentage in green basil and green kale plants. On the contrary, the plant height and leaf area of basil and kale plants were the highest under R8B1 treatment, which has the highest red light percentage. Consistent with the morphological data, the shoot fresh weight of basil, kale, and mustard plants was the highest under R8B1 treatment, which was increased by 24%-25%, 22%-32%, and 5%-23%, respectively, compared to R1B1 treatment. The nutritional quality of basil plants, including the concentrations of phenolics and flavonoids and the antioxidant capacity of plant leaves, was improved by the combined red and blue LED treatments compared to full spectrum light treatments, and the accumulation of phenolics and flavonoids tended to increase with increasing blue light percentage. In kale plants, the nutritional quality was promoted by WFL and RIB1 treatments, which was also observed in mustard plants. Considering the yield and nutritional quality, combined red and blue LEDs with red light percentage around 75% was recommended for herbs and leafy green production under indoor controlled environment.

9:45 AM – 10:00 AM

Effects of Low Nutrient Solution pH on Hydroponic Leafy Green Plant Growth, Nutrient Concentration, and *Pythium* Zoospore Infection

Daniel P. Gillespie* and Chieri Kubota, The Ohio State University

This study examined lowering pH of nutrient solution as a new management strategy to mitigate the risk of oomycete disease incidence without influencing plant growth. Although pH below 5.0 has been shown to negatively affect oomycete pathogen growth, hydroponic nutrient solution is typically maintained within pH 5.5-6.5, as plants tend to exhibit growth inhibitions outside of this range. Nevertheless, growth inhibitions can typically be attributed to pH-dependent factors affecting nutrient availability, which may be mitigated by taking precautionary measures. We hypothesized that if plants can be grown in pH below 5.0, the risk of oomycete disease incidence may be reduced. As first steps towards development of a new nutrient solution management strategy, we determined if adjusting micronutrient concentrations in solution based on reported availability levels was effective in mitigating plant growth inhibition typically experienced at low pH. Basil and spinach plants were grown in hydroponic systems with pH maintained at 4.0, 4.5, 5.0, or 5.5. Two nutrient solutions (with and

An asterisk (*) in front of a name indicates the presenting author.

without micronutrient adjustments) were applied at each pH level, where concentrations of copper, zinc, manganese, and boron were decreased by one-half and molybdenum concentration was doubled in the adjusted solution. To our surprise, basil plant growth was not affected by pH for a range of 4.0-5.5 or nutrient solution adjustment. Alternatively, spinach plant growth was significantly reduced in pH below 5.0. Using basil plants, we examined the efficacy of lowering pH in preventing *Pythium* infection. Nutrient solution pH was maintained at 4.0 or a conventional range (pH 5.5-6.5) and inoculated with *Pythium aphanidermatum* zoospores. Disease symptomology was almost exclusively limited to pH 5.5-inoculated treatments. Additionally, fresh plant mass was significantly reduced in pH 5.5-inoculated. The results of this study indicate that low pH (pH 4.0) can effectively suppress *Pythium aphanidermatum* disease incidence after zoospore inoculation without influencing basil plant growth.

Specified Source(s) of Funding: The Ohio State University, Department of Horticulture and Crop Science

Genetics & Germplasm 1

Moderator: Erin Pfarr
Rutgers University, New Brunswick, NJ, USA

9:45 AM – 10:00 AM

A Genome-Wide Association Study for Plant Architecture in a Diploid Rose Collection

Ellen L. Young*; Jeekin Lau; Patricia Klein and David H. Byrne, Texas A&M University

Plant architecture, which is determined by both genetic and environmental effects, greatly affects the appearance and desirability of ornamental plants, including roses. Cultivars with full, compact plant architecture are preferred, but phenotyping for architecture traits is time-consuming and complex. Thus, molecular markers associated with rose plant architecture traits are desirable. To that end, 84 diploid cultivars were phenotyped for five architecture traits—number of primary shoots, apical dominance as determined by the ratio of number of secondary shoots to the length of the primary shoot, growth habit, plant height, and plant volume—in spring and winter 2018 in College Station, Texas. Statistical analyses were conducted in JMP v4. The cultivars were also genotyped for single nucleotide polymorphisms via genotyping by sequencing, resulting in approximately 8000 markers that were considered useful for subsequent analyses. STRUCTURE and GAPIT were used to determine population structure and perform a genome-wide association analysis, respectively. The cultivars were found to form five subpopulations. A significant SNP on chromosome 1 was found for number of primary shoots in spring (LOD=6). Though not strictly significant, SNPs of interest were also identified for growth habit (chromosome 3), plant height (chromosome 3), and plant volume (chromosomes 2, 3, and 5). While further studies are needed, this indicates that developing markers for plant architecture in roses is a feasible goal.

Specified Source(s) of Funding: “Combating Rose Rosette Disease: Short Term and Long Term Approaches” (2014-51181-22644/SCRI)

10:00 AM – 10:15 AM

Genome-Wide Association Study Identifies a Single Locus That Co-Segregate with Inflorescence Shape in Hydrangea

Xingbo Wu*, Oak Ridge Institute of Science and Technology and Lisa Alexander, USDA-ARS

Hydrangea macrophylla is one of the most important floral and nursery crops worldwide. However, breeding of new hydrangea varieties has been hampered by its long breeding cycle and lack of genetic resources. The goal of this research was to employ genotyping-by-sequencing (GBS) for single nucleotide polymorphism (SNP) marker development and genome-wide association study of inflorescence shape, a key horticultural trait of hydrangea. This study investigated genetic diversity of 83 hydrangea cultivars using (GBS). A total of 5,805 high quality SNPs were identified and used for genetic diversity and genome-wide association study of inflorescence shape. Diversity studies confirmed the taxonomic classification of *H. macophylla* ssp. *serrata* as a subspecies of *H. macrophylla*. Population structure revealed a second gene pool within *H. macrophylla* ssp. *macrophylla* group. GWAS was performed with three models: general linear model (GLM), general liner model with Q (structure) as covariates, and mixed linear model (MLM) with Q as covariates. 93 shared SNPs were detected under two GLM models with one more additional SNP identified in GLM+Q model using the Bonferroni threshold (8.7E-6). Only the lead SNP in two GLM models was identified in MLM+Q model under the same threshold. The lead SNP explained 65.51% and 36.12% of phenotypic variation in GLM and MLM, respectively. This SNP was converted to a cleaved amplified polymorphic sequence (CAPS) marker that was able to accurately identify inflorescence shape in a validation panel. The accurate categorization of hydrangea germplasm is essential to capture available genetic diversity for hydrangea breeding improvement, and the development of CAPS and other molecular markers will reduce time-to-market for improved hydrangea varieties.

10:15 AM – 10:30 AM

Genome-Wide Association Study of the Resilience to High Temperature of Faba Bean (Vicia faba L.) Germplasm

Jinguo Hu*, USDA--ARS; Fouad Maalouf, International Centre for Agricultural Research in Dry Areas (ICARDA),; Zhiwu Zhang, Washington State University and Long-Xi Yu, USDA Agricultural Research Service, Western Regional Plant Introduction Station, Washington State University

Our research on enhancement of faba bean (Vicia faba L.)

has the objectives of increasing resilience to temperature extremes and improving nutritional quality. We conduct traditional field/greenhouse experiments and adopt contemporary genomics approaches in our independent and collaborative research projects at the Western Regional Plant Introduction Station (WRPIS), one of the four regional plant introduction stations in the US Department of Agriculture-ARS National Plant Germplasm System (NPGS) with the mission of acquiring, documenting, maintaining, characterizing, evaluating and distributing plant genetic resources to the global research community to improve agricultural productivity for food security. In collaboration with the International Center for Agricultural Research in the Dry Areas, Terbol, Lebanon and supported by a grant from the CGIAR-U.S. University Linkages Program, we collected data for eight agronomic traits on a Generation Challenge Program (GCP) reference set of 140 faba bean accessions grown under high temperature at different locations in Lebanon and USA. We also genotyped the reference set with the genotyping by sequencing (GBS) technique which produced approximately 4 million reads per genotype on an Illumina HiSeq 2500 Sequencer. The single nucleotide polymorphism (SNP) marker calling pipeline UNEAK (Universal Network Enabled Analysis Kit) found 10,950 variant loci from the sequence data. After fileting SNPs with missing rate over 60% and minor allele frequency less than 5%, 2,632 SNPs were obtained for final analyses. The final dataset contained 131 accessions with SNP call rate above 70%. The missing SNPs were imputed by LinkImpute. Genome-Wide Association Study (GWAS) was performed using the program BLINK (Bayesian-information and Linkage-disequilibrium Iteratively Nested Keyway). Four SNP markers were identified to be significantly associated with plant height (2 SNPs) and seed size (2SNPs). Upon further validation, these markers will be useful for marker-assisted selection to breed faba bean variety with increased resilience to high temperature.

Specified Source(s) of Funding: CGIAR-U.S. University Linkages Program

10:30 AM – 10:45 AM

Genotyping-By-Sequencing Diversity Study of Big-Bracted Dogwood (*Cornus* ssp.) Cultivars and Wild-Collected Accessions

Erin Pfarr*; Jennifer Vaiciunas; Christine Kubik; Josh Honig; John Michael Capik and Thomas J. Molnar, Rutgers University

Big-bracted dogwoods (*Cornus* ssp.) are small, spring-flowering ornamental trees prized for their beautiful blooms with showy bracts, attractive fruit, and fall color. *Cornus florida* and *C. kousa* are two of the most popular species for cultivated landscapes. *Cornus florida* is native to the eastern United States and blooms early in the spring before its leaves appear. The Asian native *C. kousa* blooms about a month later and has gained popularity in recent years due to its improved disease and pest tolerance. Hybrids between the two species can also be found in cultivation. In this study, we used the genotyping-by-sequencing (GBS) approach to discover single nucleotide polymorphism (SNP) and insertion and deletion (indel) markers in the Rutgers University *Cornus* cultivar collection (n=108) and in wild-collected *Cornus* from several arboretums' collections (n=30). This marker data was used to examine relationships, clonal identities, genetic diversity, and population structure. DNA was extracted using the Qiagen DNeasy Plant Kit and quality controlled with a spectrophotometer. To prepare the GBS libraries, DNA samples were double digested with PstI-HF and MspI restriction enzymes, barcoded, and multiplexed. The libraries were sequenced by Genewiz labs in South Plainfield, NJ using paired-end Illumina sequencing. SNPs and indels were called by the bioinformatics pipeline GBS-SNP-CROP and the 1,250 most informative markers were used in downstream analysis. A cluster dendrogram was made with the R package pvclust, population structure was investigated with STRUCTURE, and diversity indices and relationships between and among the cultivars and wild-origin accessions were calculated. The results provide valuable insight into the genetic diversity and population structure of these important landscape plants. They can guide future germplasm collection efforts and aid parental selection in breeding by helping to avoid choices that may narrow the gene pool.

10:45 AM – 11:00 AM

Genomic Resources for Cross-Referencing Physical and Genetic Mapping Information, Reconciling Independent Linkage Group Nomenclatures, and Enabling Genome-Informed Breeding in Octoploid Strawberry

Michael A. Hardigan[1]; Mitchell J. Feldmann[1]; Dominique D.A. Pincot[1]; Nicolas Cobo[1]; Anne Lorant[1]; Mirko Ledda[1]; Charlotte Acharya[1]; Randi A. Famula[1]; Glenn S. Cole[1]; Steven J. Knapp*[1] and Patrick Edger[2], (1)University of California, Davis, (2)Michigan State University

The genome of garden strawberry (*Fragaria × ananassa*) is a mosaic of multiple wild species genomes, albeit dominated by the contributions of the original octoploid progenitors *F. virginana* and *F. chiloensis*. Our laboratories, along with several collaborators, reported the first chromosome-scale assembly of the octoploid strawberry genome in early 2019. Over the last year, we developed additional genomic resources built on the backbone of the octoploid reference genome. Here, we describe those resources, in addition to presenting highlights of results from genome-scale analyses of nucleotide diversity and high-density genetic mapping of the genomes of the octoploid progenitors. The genomes of 142 octoploid individuals were whole-genome shotgun sequenced. These included phylogenetically and demographically diverse *F. virginiana* and *F. chiloensis* ecotypes and horticulturally diverse heirloom and modern *F. × ananassa* cultivars. We identified 95M DNA variants—astonishingly, 45M DNA variants were identified in *F.* × *ananassa*. Through stringent filtering and selection of sub-genome specific DNA sequences, two high-density single nucleotide polymorphism (SNP) genotyping arrays were developed, one with 850,000 and another with 49,000 SNPs anchored to the octoploid reference genome. SNPs on the 850K array target an estimated 94% of the 108,000 annotated genes in the octoploid. Through population genomic analyses of 850K SNP array profiles, we clearly resolved the population structure of a global collection of *F.* × *ananassa* cultivars spanning nearly 200 years of breeding. The genomes of *F. virginiana*, *F. chiloensis*, and *F.* × *ananassa* were densely genetically mapped using DNA variants identified by whole-genome shotgun sequencing, 49K SNP array genotyping, or a combination thereof. This yielded a high density of genetically mapped DNA markers across the genome—2M DNA variants in 12,000 bins were genetically and physically mapped in *F. chiloensis* alone. The resources and results described here facilitate the reconciliation and unification of independent linkage group nomenclatures and supply the community with a facile and highly accessible platform for cross-referencing genetic and physical mapping information. This is particularly important because multiple independent linkage group nomenclatures have emerged over the last two decades in strawberry without DNA-sequence information critical for cross-referencing. Finally, these resources should empower and broadly impact genome-informed agricultural and biological research in octoploid strawberry.

11:00 AM – 11:15 AM

A Chromosomal Location Associated with Male Sterility in Squash

Geoffrey Meru*[1]; Vincent Michael[2] and Yuqing Fu[1], (1)University of Florida-TREC, (2)University of Florida

Genetic male sterility in squash (*Cucurbita pepo* L.) is controlled by a single recessive gene designated *ms-2*. The phenotype is characterized by shriveling and browning of the androecium. Deployment of *ms-2* in commercial production of hybrid seeds would eliminate the need for emasculation or defloration. However, its application is limited due to inability to easily distinguish male fertile from male infertile plants in the field. Availability of DNA markers linked to *ms-2* gene would allow marker-assisted selection (MAS) for male sterile plants prior to sowing through a seed-based genotyping system (seed chip technology). However, no information is currently available on the genetic loci underlying *ms-2* in *C. pepo*. The goal of the current study was to identify the chromosomal location for *ms-2* using an F_2 population segregating for male sterility (TQ x #181761-36P). The F_2 population was phenotyped at flowering stage in the greenhouse, while SNP genotyping was performed using a seqSNP platform (LGC genomics). Approximately 60% of the SNPs assayed were polymorphic between the parents, and were used to generate a linkage map spanning 20 *C. pepo* linkage groups. A major QTL explaining 50% of the phenotypic variation observed in the F_2 was mapped on LG 4 in a region containing a candidate gene involved in male sterility across many plant species. Several SNPs adjacent to this QTL are good candidate for MAS for male sterility in *C. pepo.* Further work is underway to validate CAPS markers targeting these SNPs.

11:15 AM – 11:30 AM

Differential Recombination Rates Among Cultivars in Apple

Stijn Vanderzande* and Cameron Peace, Washington State University

Fruit breeding for superior new cultivars is based on creating individuals with improved combinations of genetic factors (alleles) for genomic regions (loci) controlling key traits. Favorable and unfavorable alleles will be passed on to the next generation independently of each other as long as they are located on different chromosomes. However, many loci controlling key traits are located on the same chromosome, such as in quantitative trait locus hotspots. In those cases, a favorable allele for one locus might be physically linked in coupling phase to a second locus's favorable allele, or favorable alleles might be linked in repulsion phase, and inheritance of the alleles is not independent. However, this linkage relationship can be changed through recombination during gamete formation. When favorable alleles are in coupling phase, this recombination would likely be undesirable, whereas for favorable alleles in repulsion phase recombination is likely desired. Thus, a better understanding of recombination rates is helpful in creating new allelic combinations or maintaining existing combinations.

Accurate information on the location and frequency of recombination events requires genome-wide marker information and pedigreed germplasm to follow these recombination events through generations. Such data is now available for apple, developed by the RosBREED project. In that project, a pedigreed germplasm set was created, representing important parents for the U.S. apple breeding programs and individuals within this germplasm were genome-scanned with the apple 8K SNP array. These SNP data were curated to obtain a high-quality phased data set of genome-wide haplotypes that enables tracing the inheritance of chromosomal segments and identifying recombination events between generations.

The average number of recombination events during gamete formation (as observed through examined offspring) in apple is 10.7 ± 3.1 which corresponds to an average number of recombination events per chromosome of 0.6 ± 0.6. An average of 7.7 ± 2.1 of apple's 17 chromosomes did not show any recombination during gamete formation. Furthermore, a difference in recombination frequency was found among important breeding parents. The lowest average recombination frequency observed was 8.8 in 'Gala' whereas the highest was 14.1 in 'Cripps Pink'. Knowledge of this difference in recombination frequency will enable development of breeding strategies involving alleles at QTL hotspots and introgression of useful wild alleles.

Herbs, Spices, & Medicinal Plants 1

Moderator: Clinton Shock
Oregon State University, Ontario, OR, USA

9:45 AM – 10:00 AM

Enhanced Nutrient Profiles of Culinary Herb Microgreens after Sodium Selenate Biofortification in Hydroponic Conditions

Rachel G. Newman*[1]; Youyoun Moon[1]; Carl E. Sams[2]; Janet C. Tou[1] and Nicole L. Waterland[1], (1)West Virginia University, (2)The University of Tennessee

Selenium (Se) biofortification of edible plants has been suggested as a method of increasing dietary Se intake. Popular culinary herbs such as scallions (*Allium fistulosum*), basil (*Ocimum basilicum*), and cilantro (*Coriandrum sativum*) are used for enhancing flavors of meals and present an opportunity as a small dietary addition for achieving supra-adequate Se intake. Microgreens are young seedlings harvested with or without one to two true leaves and are increasingly popular in the consumer marketplace. In this study, scallion, basil, and cilantro microgreens were treated with 0.0, 2.5, and 5.0 $mg \cdot L^{-1}$ of Se as sodium selenate in the hydroponic nutrient solution. Scallions, as an *Allium* species and accumulator of Se, were treated with an additional dose of 10.0 $mg \cdot L^{-1}$ of Se. The effect of biofortification on plant yield, mineral content (selenium, sulfur, sodium, potassium, phosphorus, calcium, magnesium, copper, iron, manganese, zinc, and boron), total phenolic compounds, and antioxidant capacity were assessed on a fresh weight basis. Results showed all three culinary herbs increased Se content with increasing Se concentrations in the nutrient solution. The highest levels of treatment increased Se content by 507, 155, and 40 times for scallions, basil, and cilantro, respectively. At 10.0 $mg \cdot L^{-1}$ of Se, scallions demonstrated increases in all minerals analyzed, total phenolic compounds (113.7%), and total antioxidant capacity (152.2%), but plant yield decreased by 68.0%. At the highest treatment for basil and cilantro, 5.0 $mg \cdot L^{-1}$ of Se, basil increased potassium, phosphorus, sulfur, total phenolic compounds (102.6%), and antioxidant capacity (68.6%), but decreased plant yield by 35.5%. Cilantro demonstrated an increase in sodium, total phenolic compounds (50.3%), and antioxidant capacity (66.0%) without an effect on plant yield. Overall, results showed sodium selenate biofortification can be used to enhance the content of Se, other minerals relevant to human health, and antioxidants in culinary herb microgreens. Nutritionally, scallions at 10.0 $mg \cdot L^{-1}$ of Se can offer the highest source of Se with the added benefits of increases in other minerals and antioxidants. Further, promotion of Se-biofortified culinary herbs as a functional food can enable growers to offset the loss of plant yield with higher economic returns.

10:00 AM – 10:15 AM

Influence of Substrate and Temperature on Seed Germination Percentage in Butterfly Pea (*Clitoria ternatea*)

Sean Campbell*, Univ of Florida; Brian Pearson, University of Florida, Mid-Florida Research and Education Center and Chris Marble, University of Florida

Having originated in the Asian tropics, butterfly pea (*Clitoria ternatea*) is an herbaceous, perennial leguminous twiner, meaning it climbs by encircling a vertical support. The flowers are a deep blue to purple color and when dried have long been used as a food colorant in Southeast Asian cuisine; the powdered form of *C. ternatea* flower extract tends to be more convenient, with a longer shelf life, when compared to synthetic blue colorants. The first stage in the plant life cycle, seed germination viability and percentage is influenced by a variety of internal and external factors and can have significant effects on commercial production operations. The following experiment further investigated two other factors influencing seed germination percentage in *C. ternatea*, substrate and temperature. Three different trials were performed of the same experimental design, one each per week across the span of three weeks from 17 September to 8 October 2018. Two different substrates were utilized for the experiment, the Fafard 4P soilless substrate mix and rockwool, and the propagation unit used consisted of heating mats programmed to maintain 21.1°C (70°F), 26.7°C (80°F) and 32.2°C (90°F) for the top, middle and bottom tiers respectively. Six germination parameters were recorded daily, including germination capacity (G), mean germination time (MT), coefficient of variation of the germination time (CV_t) and mean germination rate (MR). Given the lack of significance observed in the temperature by substrate interaction effect, and with significance in the germination capacity (G) (p value = 0.0344), mean germination time (MT) (p value = 0.0109), coefficient of variation of the germination time (CV_t) (p value = 0.0111) and mean germination rate (MR) (p value = 0.0269) parameters for the substrate independent variable, it can be concluded that the rockwool substrate treatment performed significantly better than the soil substrate treatment. Similarly, significant differences were observed among temperature independent variable treatments in the mean germination time (MT) (p value = 0.0096), coefficient of variation of the germination time (CV_t) (p value = 0.0056) and mean germination rate (MR) (p value = 0.0293) parameters, to which it can be concluded that the 21.1°C (70°F) and 26.7°C (80°F) treatments performed significantly better than the 32.2°C (90°F) treatment. Future research will be conducted to further investigate the influence of temperature, substrate and other independent variables on seed germination percentage in *C. ternatea*.

Specified Source(s) of Funding: University of Florida

10:15 AM – 10:30 AM

Exploiting Naturally Occurring Variants for En-

An asterisk (*) in front of a name indicates the presenting author.

hanced Health Benefits in *Lonicera* Species

Xiaoming Wang[1]; Huijie Zeng[1]; Yongxin Li[1]; Neng Cai[1]; Zhongquan Qiao[1]; Xiangying Wei[2] and Jianjun Chen[*3], (1) Hunan Academy of Forestry, (2)University of Florida, (3) University of Florida, Mid-Florida Research and Education Center

Naturally occurring variants and mutants have been widely used for improving agronomic and horticultural value of crops. However, information regarding the use of variants and mutants for improving nutraceutical and pharmaceutical value of medicinal plants is limited. In this presentation, we report the exploitation of naturally occurring variants for improving health benefits in *Lonicera japonica* and *L. macranthoides*. Flowers of *Lonicera* have been used to produce flos lonicera, which has been used as a popular traditional Chinese medicine for thousands of year. We will discuss the isolation and identifications of variants from the two species in the regions of their origination, their phenotypic characteristics, flower yield, and key compounds, particularly chlorogenic acid as it has multiple pharmacological actions including antioxidation, anti-bacteria, antivirus, anti-inflammatory, and anti-liver fibrosis. Our results suggest that the centers for crop plants' origination and domestication are the centers for valuable genetic resources. Exploring and exploiting the genetic resources could lead to identification of valuable variants or mutants that have enhanced nutraceutical and pharmaceutical value for commercial application.

10:30 AM – 10:45 AM

What Consumers Want? - Market Survey Provides Insights for Growing Tea, a New Specialty Crop for Louisiana

Yan Chen[*1]; Kathryn Fontenot[2] and Mary Sexton[2], (1) Louisiana State University Agriculture Center & Research Station, (2)LSU AgCenter

Tea plants, *Camellia sinensis*, are highly adaptable to southeastern Louisiana and are becoming more widely known in the Gulf States. Unique specialty crops such as tea have a niche market in the Southeast. However, before developing an industry for this new crop, it is important to gain a valid understanding of consumer preferences and willingness to purchase locally-grown or value-added products derived from such crops. A viable market must be in place prior to producing large acreages of specialty crops. Funded by the LaDAF, a LSU AgCenter research project on tea has conducted a consumer survey and generated interesting results based on responses from tea consumers in Louisiana. Demand for various types of tea and preference in tea's origin and desires for specific production practices such as sustainable, organic, or integrated pest management were surveyed. Consumers' willingness to pay (WTP) at ranging price points for these attributes were also determined. As current and perspective tea growers are looking for business strategies, results generated from this project will help them better understand the market and where the niche is that they would like to fit in.

Specified Source(s) of Funding: Louisiana State Department of Agriculture and Forestry

10:45 AM – 11:00 AM

The Influence of Average Daily Temperature and Daily Light Integral on Growth, Development, and Color of Purple Basil, Sage, and Spearmint

Kellie J. Walters[*1]; Sean Tarr[2] and Roberto G. Lopez[1], (1) Michigan State University, (2)Michigan State Univeristy

Greenhouse average daily temperature (ADT) and daily light integral (DLI) can be adjusted to improve crop timing, maximize biomass production, and increase crop quality. However, ADT and DLI models must be generated to aid growers. Therefore, our objective was to determine how ADT and DLI influence the growth and development of purple basil 'Dark Opal' (*Ocimum basilicum*), Sage 'Extrakta' (*Salvia officinalis*), and spearmint 'Spanish' (*Mentha spicata*) and the color of purple basil. Sage and purple basil seeds were sown and mint cuttings were stuck in rockwool cubes and grown in a greenhouse at 23 °C until transplant. On 19 April 2018 and 30 Oct. 2018 seedlings and liners were transplanted into one of five greenhouse compartments with ADT set points of 23, 26, 29, 32, or 35 °C. Each greenhouse contained three 1 by 2 m deep-flow hydroponic systems under 0, 30, or 50% shade cloth used to create target DLIs of 7, 9, or 12 $mol \cdot m^{-2} \cdot d^{-1}$. After 3, 4, or 5 weeks (mint, purple basil, and sage, respectively) leaf color (purple basil only), branch number, height, growth index, F_v/F_m, stem and leaf fresh and dry mass, and leaf area of the 4 most newly mature leaves were measured. ADT and DLI generally did not interact to influence growth or development. As DLI increased, the fresh mass of all species increased. Fresh mass of mint increased as temperature increased from 23 to 29 or 32 °C, then decreased as temperature further increased to 35 °C. Sage fresh mass decreased as temperature increased from 23 to 35 °C while purple basil had the opposite trend with fresh mass increasing with increasing temperature. However, the temperature increase that promoted purple basil growth also resulted in greener foliage color. In contrast, the higher DLIs that promoted growth resulted in less-green basil with more purple pigmentation. Additionally, leaf area generally decreased as temperatures increased from 23 to 35 °C. For example, mint, purple basil, and sage grown at 23 °C had 86, 73, and 206 % larger leaves, respectively than those grown at 35 °C. Taken together, ADT and DLI can have a large impact on growth, plant morphology, and color. The models created in this study can serve as a grower decision-support tool to improve culinary herb yields and quality.

Specified Source(s) of Funding: U.S. Department of Agriculture National Institute of Food and Agriculture, Hatch project MICL02472

11:00 AM – 11:15 AM

Can the Creation of Tetraploids Improve the Productivity and Quality of *Stevia rebaudiana*?

Clinton C. Shock* and Solomon Yilma, Oregon State University

Stevia rebaudiana is the source of steviol glycosides, which act as natural non-caloric sweeteners. It would be economically advantageous to increase the productivity of steviol glycosides. Previous research has described tetraploids with shorter internode lengths and enhanced leaf size, leaf thickness, leaf productivity, and concentrations of the rebaudioside A. Rebaudioside A is a commercially important steviol glycoside. A common method to generate tetraploids has been to treat *Stevia* seed with colchicine and then evaluate the seedling plants produced in comparison with the parental lines. The methodology of treating seeds leaves in doubt whether or not the improved performance is a result of the creation of tetraploids or the inadvertent result of selection among the progeny. *Stevia rebaudiana* is inherently an outcrossing species and the seedlings vary genetically from the parents. To examine the potential advantages of tetraploids, the apical meristems of a diploid line with high rebaudioside A productivity were treated with colchicine, inducing a tetraploid line. Following vegetative reproduction through cuttings, both the diploid line and the resulting tetraploid were evaluated for leaf size leaf productivity, and 14 steviol glycosides in a field experiment at Ontario, Oregon in 2017. Although tetraploid leaf size was larger, the tetraploid resulted in decreases in dry leaf rebaudioside A content (8.4% vs 9.4%, P=0.009), dry leaf total steviol glycoside content (11.4 vs 12.8% P =0.01), and dry leaf productivity (3.3 vs 4.0 Mg/ha, P =0.008). The entire laboratory, vegetative reproduction, and field procedures were repeated in 2018 to compare three tetraploids with their diploid lines. In 2018 the leaf size and thickness were greater in the tetraploids. The tetraploids had statistically similar but lower levels of rebaudioside A (14.4% vs 15.1%, P =0.61) and total steviol glycosides (18.6 vs 18.9% P =0.75), but again leaf productivity declined (4.3 vs 6.0 Mg/ha, P =0.0002). These results suggest that improvements in *Stevia* productivity or steviol glycoside content via the generation of tetraploids alone may have limited success.

Specified Source(s) of Funding: Scientific Ecological Services, Ontario, Oregon

11:15 AM – 11:30 AM

Increasing Agricultural Profitability through Sustainable Year-Round Inter Cropping and Utilization of Mushroom and Companion Crops

Worlanyo Segbefia* and Patrick Igbokwe, Alcorn State University

Field experiments were used to determine the effect of year-round row-inter cropping on “Shiitake” and “Oyster” mushroom growth, yield potential, soil and water quality, product development and consumer acceptance. Growth and yield potentials of both indoor and outdoor-grown Shiitake mushrooms were also compared. The study also determined the growth and yield potential for outdoor-grown “Garden Giant” mushroom patches. Findings indicated that both Shiitake and Oyster mushroom blocks planted outdoors were unproductive during the first growing season until adequate overhead sprinkler irrigation and partial shading from companion vegetables and herbs were provided during the second growing season. Shiitake and Oyster mushroom blocks planted outdoors in a growing season produced marketable yields into the following growing season when factors of production were not limiting. Total phosphorus in the runoff was higher for Claiborne County compared to Jefferson County. Both Nitrate (NO_3-N) and Nitrite (NO_2-N) were not different for the two counties. Marketable yields from outdoor-grown Shiitake mushrooms were greater than those from indoor-grown mushrooms. They were also higher in their macro nutrient levels. Both productivity and profitability were greater for Shiitake mushroom compared to those reported for Oyster mushrooms. Both Shiitake and Oyster mushrooms can be grown year-round outdoors in Southwest Mississippi if proper strain(s) for each planting season are planted and growth factors are not limiting.

Nursery Crops

Moderator: Amanda Bayer
University of Massachusetts, Amherst, MA, USA

10:00 AM – 10:15 AM

Growth Stage Affects Sensitivity of Nursery Crops to Residual Pesticides in Runoff Irrigation

Shital Poudyal*, Michigan State Univ and Bert Cregg, Michigan State University

Interest in using runoff water for irrigation of ornamental crops is increasing among nursery producers due to the rise of water scarcity and water regulation in many parts of the U.S. However, concerns about potential crop damage from contaminants in recycled water, including residual pesticides, may be a barrier for growers to adopt irrigation recycling technologies. Past research suggests that pesticide concentrations in recycled water are generally safe for woody ornamental plants, but visual injury and reductions in physiological responses and growth are sometimes reported. It is widely assumed that sensitivity of plants to residual pesticides is greater at early growth stages but few systematic studies have been conducted. In this trial, we evaluated the effect of simulated nursery runoff containing two pesticides, either oxyfluorfen (0.02 ppm) or oryzalin (8 ppm) on various growth stages of *Hydrangea paniculata* ‘limelight’ in terms of physiological responses, growth and visible injury. Dormant plants in #3 (12L) containers that had been over-wintered in an unheated hoop-house were placed in a heated (22°C) greenhouse. Once all plants began a new flush of growth, four sub-sets of 5 plants received runoff exposure via an overhead irrigation system for 10 days.

Runoff irrigation began either 5, 15, 25, or 35 days after the initiation of growth. One sub-set of 5 plants (control) was irrigated with well-water throughout the experiment. Plants in each exposure group were watered with well-water before and after the 10-day exposure. After simulated pesticide runoff treatment, we measured net photosynthesis (A_{max}) and light adapted chlorophyll fluorescence (fv/fm), along with visual injury (leaf browning, misshapen growth) and growth index 1, 10, and 20 days after treatment and at the end of the study. Plants that were exposed to pesticide at earlier stage of growth had greater visible injury compared to later exposure dates. Oxyfluorfen produced maximum damage immediately after exposure but for oryzalin, damage was progressive and maximum damage was observed at 10 days after the exposure. Physiological responses (A_{max} and fv/fm) were also affected by date of exposure. These results suggest that nursery managers may be able to reduce potential risks associated with residual pesticides in runoff irrigation by minimizing exposure to plants immediately after new flush of growth.

Specified Source(s) of Funding: Project GREEEN and Michigan Department of Agriculture and Rural Development (MDARD)

10:15 AM – 10:30 AM

Tools for Growers to Efficiently Manage Water for Specialty Crop Production

John Majsztrik*[1]; Saurav Kumar[2]; Bruno J.L. Pitton[3]; Lorence R. Oki[3]; Daniel Hitchcock[1]; David Sample[4] and Sarah A. White[1], (1)Clemson University, (2)University of Texas at El Paso, (3)UC Davis, (4)Virginia Tech

What good are tools if the intended users do not use them? The Clean WateR[3]team, using input and feedback from growers, has developed or refreshed a number of useful tools for specialty crop growers. These tools are available online and grouped for easy access in one convenient location. The tools discussed in this presentation include: 1) A slow sand filter sizing tool to determine how to size a slow sand filter based on desired treatment volume. 2) A chlorine contact time tool used to determine if chlorine has enough contact time for effective disinfection of water. This tool will also determine what size tank is needed in addition to the irrigation pipe to achieve sufficient contact time for a given pump capacity and pipe volume. 3) The coefficient of uniformity tool to help growers test sprinkler system uniformity. This tool can help growers determine how efficiently they are applying irrigation water. 4) The pond refill calculator helps growers' determine how much water from irrigation or rainfall runoff returns to a pond. This tool can also be used to determine retention pond sizing for capturing rainfall runoff to meet water quality regulations or irrigation needs. And, 5) The pathogen risk evaluator helps growers determine which practices put them at greater risk for pathogen contamination and spread in their operation.

Specified Source(s) of Funding: This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2014-51181-22372

10:30 AM – 10:45 AM

The Efficacy of Chlorine in Controlling the Spread of *Fusariun Oxysporum* in Angiosperms

Russell Chung* and Hirak Chavda, Myron L Company

The spread of *Fusarium oxysporum* like pathogens, have been reported to be extremely difficult to remove once it spreads through a nursery, whether it is in the irrigation delivery system or in storage tanks. Free chlorine has been reported to be effective in spore inactivation. Also, many growers mix the free chlorine with nutrient solutions as a convenient method of delivery.

In this study, we investigated the speciation and lifetime of chlorine, in different types of makeup water, including reverse osmosis water, city water supply and a common nutrient solution N-P-K matrix using UV-VIS spectroscopy. Furthermore, we also studied the inactivation effectiveness, inferred from pathogen culture on potato dextrose agar, of the various chlorine species and contact time up to 50 ppm in concentration and 60 minutes respectively. Furthermore, we compared the sole capability of a filtration method to remove *Fusarium* spores versus the chemical method, with filtration pore size ranging from 200 um to 0.2 micrometer.

As a matter of practical field use in quantifying the appropriate free chlorine level, we have also tabulated the ORP and pH values for a common N-P-K matrix using a handheld instrument, with chlorine levels and species data derived from UV-VIS spectroscopic measurement. The effectiveness of these ORP-pH values in providing the correct level of inactivation is also demonstrated with irrigation water sampled from a local nursery.

Specified Source(s) of Funding: Myron L Company

10:45 AM – 11:00 AM

Impact of Soil Additives on Plant Growth and Substrate Water Retention

Amanda Bayer*, University of Massachusetts

Hydrogels polymers to improve substrate water retention and increasing in popularity. The effectiveness of these hydrogels are influenced by substrate properties as well as fertilizers in the substrate. The aim of this research was to quantify substrate water retention and plant growth as impacted by the addition of two different hydrogels. *Hydrangea macrophylla* 'Everlasting Revolution' liners were planted in 7.6 L containers filled with one of four substrate combinations: 75% peat/25% perlite, 50% peat/50%perlite, 75% coir/25% perlite, or 50% coir/50A% perlite. Peat containing substrates had lime incorporated. There were three soil additive treatments: a control with no additive, Terra Sorb hydrogel applied at 7.1g per pot, and Soil Moist applied at 10.5g per pot. Plants were hand watered every other day with 100 mL of water for the first 4 weeks and then 200 mL of water for the remainder of the experiment. All plants received 31g of Nutricote 18-6-8. There was no effect of additive or substrate type on plant height or shoot dry weight. Although not significantly different, plants receiving the additive treatments were generally given a higher visual rating for all substrate combinations. Treatments had no effect on relative chlorophyll content. There was a significant interactive effect of additive and substrate type on weight of the container (substrate plus plant). The substrates containing 75% peat and coir had higher weights. Additives increased container weight for the substrates containing peat whereas addtivie effect was variable for coir-based substrates. There was also an interactive effect of additive and substrate type and substrate type by date on substrate pH. Substrate pH generally increased over the duration of the experiment for the peat containing substrate combinations, whereas coir containing substrates varied. Soil additives improved substrate water retention, with the effectiveness influenced by substrate type. Plant growth was unaffected during the duration of the experiment.

Specified Source(s) of Funding: This material is based upon work supported by NIFA, USDA, UMass CAFE, and the Stockbridge School of Agriculture at University of Massachusetts Amherst, under project number MAS00487.

11:00 AM – 11:15 AM

Effect of Dolomite and Micronutrient Fertilizer on Phosphorus Form and Uptake Efficiency When Growing Containerized *Lagerstroemia* L. 'Natchez'

Jacob H. Shreckhise*[1]; James S. Owen Jr.[2]; James Altland[1] and Alexander X. Niemiera[2], (1)USDA-ARS, MWA ATRU, (2)Virginia Tech

Pine bark is the primary substrate component used for containerized nursery crop production in the eastern United States. Poor phosphorus (P) uptake efficiency (PUE) of crops produced in pine bark substrate is a commonly reported issue that can have environmental and monetary consequences. In addition to a complete macronutrient fertilizer (primarily controlled-release), dolomitic limestone and a micronutrient fertilizer are routinely added to pine bark-based substrates to improve fertility. However, the effect of these preplant amendments on PUE of containerized crops has not been thoroughly investigated. Additionally, the influence of dolomitic limestone and micronutrient fertilizer on the form of P in substrate pore-water is not well understood and may provide insight into P lability in the container. The objective of this research was to determine the effect of dolomitic limestone and micronutrient fertilizer amendments on total P (TP), total dissolved P (TDP), and orthophosphate-P (OP-P) concentrations in pour-through extracts and their relative influence on P uptake efficiency (PUE) of containerized *Lagerstroemia* 'Natchez' (crape myrtle). Containerized crape myrtle were grown in a greenhouse for 91 days in a pine bark substrate containing 2.97 $kg\cdot m^{-3}$ of a polymer-coated 19N–2.6P–10.8K controlled-release fertilizer and one of four substrate amendment treatments: no dolomitic limestone or micronutrient fertilizer (F), 2.97 $kg\cdot m^{-3}$ dolomitic limestone (FL), 0.89 $kg\cdot m^{-3}$ soluble micronutrient fertilizer (FM), or both dolomitic limestone and micronutrient fertilizer (FLM). Pour-through extracts were collected approximately weekly and analyzed for pH, electrical conductivity, nutrient concentrations, and three P fractions: TP, TDP, and OP-P. Shoots and roots were harvested at experiment termination to determine dry weight and mineral nutrient concentrations. Amending pine bark with a combination of dolomitic limestone and micronutrient fertilizer reduced pour-through OP-P and TP concentrations by 64% and 58%, respectively, when averaged across sampling dates. Total dissolved P concentrations were similar to TP concentrations in all treatments over the course of the study. In the F, FL, and FM substrates, OP-P contributed >70% of TP at all sampling dates, whereas OP-P in FLM was as low as 41% of TP. Total dry weight of plants grown in FLM or FM was 40% higher than those grown in F; however, tissue P content and PUE were the same among plants in these three treatments. Therefore, sorption of OP-P by dolomitic limestone and micronutrient fertilizer did not limit P uptake by plants.

Specified Source(s) of Funding: Hatch Program of the National Institute of Food and Agriculture (SCRI 2014-51181-22372), U.S. Department of Agriculture, and the Virginia Nursery and Landscape Association

Ecological Physiology 2

Moderator: Zach Brym
University of Florida, Homestead, FL, USA

10:15 AM – 10:30 AM

Growth, Physiological and Biochemical Responses of Tung Tree (*Vernicia fordii*) Seedlings to Different Light Intensities

Ze Li* and De-yi Yuan, Central South University of Forestry and Technology

Due to its high photosynthetic efficiency, tung tree (*Vernicia fordii*) is a fast-growing heliophile, yielding fruit within 3 years. Additionally, tung oil extracted from the fruit seeds is an environmentally friendly paint widely used in China. However, mutual shading inside a tung tree canopy leads to a low yield of fruits due to weak or dead low branches. In this project a pot experiment was conducted to understand the growth, physiological and biochemical responses of tung trees under various shading levels. Tung tree seedlings were subject to different light intensities, i.e. L100 (control): 100% sunlight (no cover), L75: 75% sunlight (25% shading), L50: 50% shading, and L20: 20% sunlight (80% shading) from June to August. Results indicated that L75 treatment significantly reduced the net photosynthetic rate, stomatal conductance, transpiration rate, total aboveground and root dry mass, maximum net photosynthetic rate (A_{max}), and maximum rate of electron transport at saturating irradiance (J_{max}) compared to the control, although plant height and leaf area were not reduced. Lower light intensitis (L50 and L20) and longer duration of treatment led to greater reduction in growth and photosynthetic potential (A_{max} and J_{max}). Chlorophyll a, chlorophyll b, and total chlorophyll content were increased in L50 and L20 in comparison to those in L100 and L75. There was no significant reduction in the enzyme activities of ribulose-1,5-bisphosphate carboxylase (Rubisco) and phosphoenolpyruvate (PEPC) of the seedlings by the L75 treatment; however, lower light intensities (L50 and L20) and longer duration of shade treatment resulted in significant reduction in enzyme activity. In summary, our results suggest that tung tree has higher photosynthetic activity under high light intensity. However, shading, even at 20%, especially for longer term, reduced photosynthetic efficiency and growth. To prevent growth reduction, tung trees should be grown under full sun with a daily light integral of approximately 46 mol·m^{-2}·d^{-1} and mutual shading should be avoided by proper spacing and pruning.

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Specified Source(s) of Funding: This work was supported by the National Key R&D Program of China (2017YFD0600703), and the National Key R&D Program of China (2017YFD0601304).

10:30 AM – 10:45 AM

Seed Germination, Drought and Salinity Tolerance of the Endangered Black Calla Lily (*Arum palaestinum* Boiss) Endemic in Mediterranean Coast.

Mohamed A Shahba*, Colorado State University

Arum palaestinum (Black Calla Lily) is one of about 26 species of the *Arum* genus belonging to *Araceae* and used in folk medicine to cure several chronic diseases such as stomach acidity, atherosclerosis, cancer, diabetes and food toxicity. Climatic changes, water shortage, salinilty, drought and destrfications are major problems affecting native plant genetic resources in arid and semiarid regions of the world. In this research, ecophysiological investigations have been done for a better understanding of Black Calla Lilly seed germination under normal and saline conditions as well as testing its drought and salinity tolerance during establishment and growth. Seeds of *Arum palaestinum* were collected from their growing habitats in Bargash protected area, Irbid, Jordan during the spring of 2015.Germination trials were performed under normal and saline conditions and resulted seedling were used for drought and salinity tolerance investigations. Water regimes tested included control (100% of the total evapotranspiration), as well as 75%, 50% and 25% of the total ET. Salinity treatments were control (Tap water), EC = 5, EC = 15 and EC = 25 dS m^{-1}. Results indicated that 30 mM thiourea, 0.01 mM fusicoccin, 10.0 mM ethephon, and 1.5mM kinetin increased seed germination percentage and speed of *Arum palaestinum* under saline conditions. Ethephon was the most effective growth regulator in ameliorating salinity effect on *Arum palaestinum* seed germination followed by kinetin, thiourea, and fusicoccin. There was no obvious drought symptoms at the level of 75% of the total evapotranspiration. In response to the level of 50% of the total evapotranspiration, *Arum palaestinum* exhibited reduction in leaf characteristics, plant height, flowering characteristics, overall plant quality (attractiveness), TNC, and ET rate, and increased shoot total reducing sugars and proline content. As salinity increased, *Arum palaestinum* exhibited reduction in leaf characteristics, plant height, TNC, and K^+/Na^+ ratio, and increased shoot total reducing sugars and proline content. All tested plants were affected at different levels at EC of 15 dS m^{-1} but all of them could not tolerate the EC of 25 dS m^{-1}. Proline accumulation could add to the drought and salinity tolerance through osmoregulation or by acting as carbon and nitrogen sink for stress recovery.

Specified Source(s) of Funding: USDA

11:00 AM – 11:15 AM

Cover Crop Growth and Competition in Representative Agroecosystems of South Florida

Zach Brym*, University of Florida

Cover crops are used widely in crop rotations for their positive impacts on environmental and biotic conditions that improve subsequent crop production. Cover crop research is often designed to modify a specific environmental or biotic condition using a cover crop application and to describe how that application improves agricultural production. However, as the focus of such research tends to be on the indirect benefits of cover crops on agricultural production, relatively little work is done to understand the basic physiology and ecology of cover crop systems. Indeed, cover crops may be used as environmental indicators to better understand agroecosystem functioning and as a model cropping system to understand crop growth and competition. A cover crop experiment was established in representative agroecosystems of South Florida (vegetable field, commercial grove, tropical fruit collection, natural area) to evaluate the growth and competition of cover crop mixtures in diverse systems. Three sub-tropical cover crops (Crotalaria juncea, Mucuna pruriens, Sorghum bicolor x S. bicolor var. sudanese) and their pair-wise mixtures were planted in a 400m^2 Latin square (6x6) in May 2018 and November 2018 in each agroecosystem. Plant growth and biomass was monitored through a 90-day and 60-day growth period, respectively. In addition, agroecosystems were classified by local weather, soil, and plant diversity. Crop growth was highly variable among the agroecosystems with higher growth in the tropical fruit collection and natural area systems that had newly cultivated soils with higher organic matter. Within agroecosystems, cover crop mixtures consistently demonstrated higher land equivalent ratio, indicating a complementarity for the cover crops in mixture as indicated by growth and biomass.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture FLA-TRC-005661 and UF/IFAS Early Career Seed Grant

Vegetable Crops Management 1

10:15 AM – 10:30 AM

Cover Crops Under Cover: Evaluating Ecosystem Services of Cover Crops in Year-Round High Tunnel Production Systems

Annette Wszelaki*[1]; Jennifer Moore[1]; Erin Haramoto[2]; Julia Gaskin[3]; Debendra Shrestha[2]; Jennifer Taylor[2] and Krista Jacobsen[2], (1)University of Tennessee, (2)University of Kentucky, (3)University of Georgia

Cover crops have well-documented benefits for soil health, pathogen suppression, and crop yields in field cropping systems, but have been less utilized in year-round high tunnel systems due to short windows for cover crops and potential lost revenue. Conservation practices that provide ecosystem services but take land temporarily out of cash crop production create trade-offs, which we examined in an experiment integrating winter cover crop treatments into a continuously cropped tomato-lettuce rotation in Kentucky and Tennessee in 2017 and 2018. The four winter treatments included: a lettuce cash crop, a winter wheat monoculture, a crimson clover monoculture, and a biculture of wheat and clover. Services evaluated included several soil parameters, nitrogen leaching, weed seed bank management, and yields. Soil samples were taken at 0-6" and 6-12" depths. Soil data were analyzed separately by site, as soil type and baseline fertility conditions varied between the two. There were no cover crop treatment effects in Kentucky. Soil K declined every year at both soil depths. In the surface layer, soil K declined from 383 lbs/ac to 213 lbs/ac. Soil K varied by treatment over time, with the treatments incorporating wheat and the biculture decreasing at the 0-6" soil depth. Soil K in the other treatments (clover, lettuce) declined numerically but were not different over time. Like Kentucky, soil K content in Tennessee decreased in each layer over time, declining from 454 lbs/ac in the surface layer to 119 lbs/acre over the course of the experiment. Weed biomass was analyzed separately by state due to differences in background weed pressure. Both states had greater weed biomass in clover compared to wheat and biculture. In Kentucky, weeds accounted for 32-56% of the biculture biomass, 61-94% of clover monoculture, and 17-53% of wheat monoculture (2017 and 2018, respectively). Poorer cover crop performance in the winter of 2017-18, relative to weeds, could be explained by lower temperatures. In Tennessee, weeds accounted for a much smaller fraction of the biomass- 2-6% of the biculture, 9-12% of the clover monoculture, and 1-9% of the wheat monoculture (2017 and 2018, respectively). Tomato yields did not differ by treatment; however, yields were higher in 2017 than 2018 and higher in Kentucky than Tennessee both seasons. Unmarketable fruit (%) increased from 2017 to 2018 and was higher in Tennessee. Much of the unmarketable fruit was due to yellow shoulder disorder, likely due to the decline in K observed during the experiment.

Specified Source(s) of Funding: Southern SARE's Research and Education Grant Program

10:30 AM – 10:45 AM

Prospects of Using Water to Mitigate Challenges of a Warming Climate in the Lower Colorado River Region Vegetable Cropping Systems

Charles A Sanchez* and Paul Brown, University of Arizona

The lower Colorado River region of the Southwestern United States supports a multibillion dollar produce industry providing product across the U.S. from November through April each year. All climate change models predict less runoff and a more saline Colorado River, although degree varies by model. Further, data complied over the past several years have shown a clear trend in warming temperatures. This has already created challenges in stand establishment and the production of product of acceptable quality in the beginning of the production season in this region. Sprinklers are already used for climate modification and their use will have to be exploited further. The use of sprinkler as an enhanced climate modification tool in the future will be discussed. An increase in salinity of irrigation water will require modification in water management and these implications will be addressed. Finally, while temporary water transfers from rural to urban interests (with compensation to rural water right holders) are a popular strategy among policy makers to address transitory shortages, they result in salinity management challenges when farm operations are resumed and the required mitigation strategies will be outlined.

Specified Source(s) of Funding: Arizona Iceberg Lettuce Research Council

10:45 AM – 11:00 AM

Evaluating Perennial and Annual Companion Plantings for Pollinator Enhancement of Yield in Small-Scale Vegetable Production.

John Montoya Jr.*[1]; Michael A. Arnold[2]; Juliana Rangel[2]; Marco Palma[2] and Larry A. Stein[2], (1)Tarleton State University, (2)Texas A&M University

Pollination is a key component to obtain proper yield and fruit set in numerous vegetable crops, with the honey bee, *Apis mellifera* L., being their primary pollinator. Honey bee populations in the United States have experienced dramatic declines, exhibiting a loss of 59% of colonies from 1947 to 2005. Likewise, several native bee species have exhibited sustained declines over the past century. We hypothesized that the placement of pollinator-attracting plants near vegetable crops would increase the yield and quality of vegetable crops by attracting a greater frequency and diversity of pollinators. This study evaluated the addition of pollinator-attracting plants in close proximity to cucumber (*Cucumis sativus* L.) and habanero pepper (*Capsicum chinense* Jacq.). Two treatment groups of pollinator-attracting plants were evaluated: perennial companion plantings adjacent to crop rows and interplanted annual companion plants within crop rows. The perennial companion plants consisted of *Phyla nodiflora* (L.) Greene, *Borrichia frutescens* (L.) DC., *Salvia farinacea* Benth. 'Henry Duelberg', and *Eysenhardtia texana* Scheele. Annual companion plants consisted of *Cosmos bipinnatus* Cav., *Zinnia × marylandica* D.M. Spooner, Stimart, & T. Boyle, *Borago officinalis* L. and *Ocimum basilicum* L. Yield was recorded and analyzed using analysis of variance tests for three successive cropping cycles. Significant differences in yield were found among treatment groups with greater yields observed in companion planting treatments, particularly with annual pollinator-attracting species, when compared to control treatments for both habanero peppers and cucumbers. Influence of pollinator attracting companion plants appeared to vary seasonally, suggesting they may be more beneficial at some seasons than others for a given crop.

11:00 AM – 11:15 AM

Application of Suas in Vegetable Crop Management

Qingren Wang*, University of Florida/IFAS Extension Miami-Dade County

This presentation is to display a small Unmanned Arial System (sUAS) in promoting vegetable crop management. The device is DJI Phantom 4 Pro associated with a multispectral sensor – double 4k developed by Sentera specifically for agricultural purposes. The vegetable crops that have been surveyed include tomato, sweet corn, beans, and okra. The data were processed with corresponding software, such as sentera FieldAgent and Drone Deploy. The result showed that in a single flight, multiple images including Red, Green and Blue (RGB), Near-Infrared (NIR), Normalized Difference Vegetation Index (NDVI), and Normalized Difference Red Edge (NDRE) were collected and processed. These data could be used to generate various Management Zones based on seed germination rate, stress of soil nutrient or moisture, plant healthy status, damages from insects or diseases, which can provide timely information to growers for their field management practices in order to reduce the yield loss. Therefore, the application of this up-to-date technology has shown a great potential in improving the Best Management Practice (BMP) for the development of sustainable agriculture.

Specified Source(s) of Funding: Florida Department of Agriculture and Consumer Service (FDACS): Best Management Practice (BMP) program

Marketing and Economics 1

Moderator: Ariana Torres
Purdue University, West Lafayette, IN, USA

10:15 AM – 10:30 AM

Crop Diversification and Market Access in the Fruit and Vegetable Industry

Nicholas Lancaster and Ariana P Torres*, Purdue University

The phrase "Don't put your eggs in one basket" captures the motivation of farmers to diversify under the current agricultural climate. From the financial standpoint, diversification is a way to mitigate risk and improve financial sustainability. Several studies have looked on the economics of farm diversification, but to our knowledge, no study has recently looked into the drivers of crop diversification among FV operations in the U.S. Moreover, there is little information how diversification may be motivated by the choice of market channels. According to Izumi et al. (2010), farm diversification can be one of the main strategies adopted by farmers as a way to respond to the increasing demand of local foods and farm-to-fork movements. For example, farmers selling in local markets may choose to grow more crops to contribute to the colorful supply of FV, a marketing strategy that can help attract customers.

A final motivation for this study relates to the definition of farm diversification in the FV industry. Numerous USDA reports, which focus on traditional row crop production, indicate that a farm producing 4 or more crops is considered diversified. For example, with the surge of organic grains, the traditional row crop industry has begun exploring the value of adding more crops to the widely adopted corn-soybean rotation, and defines a diverse operation as those rotating 3 to 4 crops. In the context of fresh market FV, where the average operation grows 20 crops, a crop mix of 3 to 4 crops does not seem to truly capture farm diversification.

We contribute to the literature in two ways. First, we used an OLS to look into the external and internal factors influencing crop diversification of FV operations. Specifically, we wanted to understand what factors drive or hinder farmers' likelihood to increase the number of crops in their FV operations. Second, we used a quantile regression to provide a comprehensive picture of the effect of external and internal factors at different degrees of crop diversification (i.e. low, medium, and high diversification). The data for this analysis came from a 2012 web-based survey of fruit and vegetable farmers who were part of the Food Industry MarketMaker database in 16 states. This study focused on a sample of 1,532 farmers that, on average, grew 17 and sold through three market channels.

The results provided evidence that selling in local markets is a major factor influencing crop diversification among fruit and vegetable operations. One explanation is that farmers selling in local markets tend to rely in trust farmer-customer relationships to receive direct feedback from customers . This feedback allows farmers to adapt their crop mix and production practices to meet demand. Another explanation is that crop diversity contributes to colorful supply of FV, which is considered an important marketing strategy to attract customers in local markets. The quantile regression helped us characterize the effects of access to local markets, farmland size and other explanatory variables at different levels of farm diversification. We categorized operations as specialized (quantile 0.25 with 1 to 4 crops), low diversified (quantile 0.50 with 5 to 15 crops), medium diversified (quantile 0.750 with 16 to 28 crops), and highly diversified (quantile 0.99 with 29 to 43 crops) and estimated the effect of the explanatory variables on each quantile. Similar to the OLS results, selling in local markets has a positive effect on crop diversification across all quantiles.

The literature showed inconsistencies regarding farm size and farm diversification. While Mishra and El-Osta (2002) reported a negative relationship between diversification and farm size, McNamara and Weiss (2005) reported that farm diversification tends to increase with farmland. We posit that these inconsistencies in the literature may be due to lumping all levels of farm diversification into a single level of dependent variables. Our quantile results elicited that increasing the farm acreage has a significantly positive effect on crop diversification for specialized farms ($P < 0.1$), but a significantly negative effect on highly diversified operations ($P < 0.05$). An explanation for this may be that having access to more acres can help specialized FV farms to add crops to the product mix. On the contrary, the highly diversified farm may have already reached its maximum crop diversity, in which an extra acre will allow growers to focus on the most economically profitable crops rather than adding a new crop to the long list of products.

This analysis contributes to the current local foods and farm diversification literature and sheds light on the barriers and drivers to increase farm diversification among FV operations. Results from the study can help researchers and policymakers to understand what it takes for farmers to diversify and mitigate risk. We also contribute to the farm diversification literature by defining diversification in the context of fresh market FV industry.

Specified Source(s) of Funding: USDA-NIFA Organic Research and Education Initiative

10:30 AM – 10:45 AM

Understanding Consumer Preferences and Buying Behaviors for Value Added Pecans

Julie Campbell* and Vanessa Shonkwiler, University of Georgia

Each year the U.S. pecan crop is estimated to a value of over $500 million. Understanding consumer preferences in labeling and packaging could help increase revenue, especially for small farms that can provide unique value added products. In the fall of 2018 an online survey of r Research findings provide us with insights into how consumers perceive value added pecan products, and helps in increasing understanding of how consumers view niche labeling of these products.

10:45 AM – 11:00 AM

Consumer Preferences for Neonic-Free Labeling: Investigating the Effects of Negative and Neutral Information in a Choice Experiment

Xuan Wei; Hayk Khachatryan and Alicia Rihn*, University of Florida

The debate surrounding the use of neonicotinoid pesticides in the U.S. has been receiving more public attention due to its increasing risk on pollinators. Despite the importance of end users' feedback, little is known about how individual consumers would react to the labeling of neonicotinoids, and how they value this additional point of sale cue. To investigate consumers' knowledge about neonicotinoid pesticides and preferences for neonicotinoid-free ornamental plants, we conducted an online choice experiment with 1200 participants. The effects of negative and neutral information were tested by incorporating two different information treatments regarding the scientific evidence on the impact of neonicotinoid on pollinators. Survey participants were randomly assigned to either the status quo control group or one of the treatment groups. A mixed logit model was used to estimate consumers' preferences for labels indicating the presence or absence of neonicotinoids, as well as several environmentally friendly production attributes. Implications for relevant policy and industry stakeholders will be discussed.

Specified Source(s) of Funding: USDA NIFA Specialty Crop Research Initiative Grant

11:00 AM – 11:15 AM

Consumer and Producer Preferences for Neonicotinoid Pesticide Labeling in the U.S. Green Industry

Hayk Khachatryan*; Xuan Wei and Alicia Rihn, University of Florida

There is an ongoing debate about the effects of neonicotinoid insecticides related regulations and labeling practices on market demand in the Green Industry. Although consumers are becoming more interested in sustainably produced products, consumer awareness of neonics is low which highlights the uncertainty around the marketplace's response to neonic-free labels. This study pairs a producer survey with a consumer study to assess differences in neonicotinoids related production costs and perceptions about mandatory and voluntary labeling regulation. Results demonstrate that producers anticipate increased costs of production if neonics are banned from production practices. Consumers show low awareness and knowledge of neonics but an increased value for neonic-free plants. Producers strongly oppose mandatory labeling while consumers largely support mandatory labeling of neonic use in plant production. Lastly, effective neonic related labeling phrases are explored from distinct producer and consumer viewpoints.

11:15 AM – 11:30 AM

One Box Does Not Check All: A Comparison of the Characteristics of Organic Certified, Organic Who Drop out the Certification, and Farmers Not Interested in Organic Certification.

Orlando Rodriguez* and Ariana Torres, Purdue University

The research of the organic certification drivers has been important to expand the supply of organic foods. However, very few studies have compared the characteristics of certified farmers with those operations that dropped out the certification program, and those that are not interested in certifying organic. The purpose of this article is three-fold: First, to determine key factors influencing farmers' lack of interest in organic certification; second, evaluate the characteristics that drive or deter farmers' to certify organic; and third, assess the main characteristics of farmers that dropped their certification status.

We used data obtained from a 2012 web-based survey of fruit and vegetable farmers that were part of the Food Industry MarketMaker database. We grouped producers in three categories. The first category was the group of farmers that were not interested in. The second group was the USDA organic certified farmers. The third group was the group of farmers that were certified and dropped the certification program. We made multiple comparisons among farmers categories in the analysis of ANOVA models using Tukey's honestly significant difference method.

The results showed that education can influence farmers to become organic certified, irrespective if they choose to drop their certification in the future. Access to labor and time on-farm business were also a key factor in affecting organic certification status. These differences suggest that organic certified farms tend to require more labor, and the lack of it may lead farmers to decertify or to be not interested. In addition, sales analysis may suggest that organic certification costs are too high for small fruit and vegetable operations. It appears the smaller the farm, the less likely they certify or remain certified. Access to market channels is a major factor influencing farmers' certification status. Most growers not interested in organic certification sell their produce mainly in direct-to-consumers channels such as farmers markets. Farmers selling directly to consumers may not need the organic label to access price premiums for organically grown produce.

Our findings can help policymakers, industry stakeholders, extension agents and researchers to derive incentives and programing to enhance the organic objectives and support the long-term sustainability of organic agriculture.

Specified Source(s) of Funding: The authors are grateful to the USDA-NIFA Organic Research and Education Initiative for funding the research.

Plant Biotechnology

Moderator: Hadil Alaydi
Limerick Institute of Technology, Limerick, Ireland

2:00 PM – 2:15 PM

Auxin Response Factors, SlARF6 and SlARF10, Regulate Chlorophyll Biosynthesis and Sugar Accumulation during Tomato Fruit Development

Yujin Yuan*[1]; Xin Xu[2]; Zehao Gong[2]; Wei Deng[2] and Cai-Zhong Jiang[3], (1)University of California Davis, (2)Chongqing University, (3)USDA-ARS

Auxin response factors (ARFs) are involved in auxin mediated transcriptional regulation in plants. We study the roles of ARFs in the regulation of fruit quality in tomato. We found that both tomato SlARF6 and SlARF10 were located in the nucleus and displayed transcriptional activity. Overexpression of *SlARF6* and *SlARF10* increased chlorophyll contents in tomato fruits, whereas down-regulation resulted in decreased chlorophyll contents compared with wild type (WT) plants. Furthermore, up-regulation of *SlARF6* and *SlARF10* increased the photosynthetic rate, accumulation of starch and soluble sugars, whereas knock-down led to opposite phenotypes in tomato. RNA-sequence analysis showed that regulation of *SlARF6* expression altered the expression of genes involved in chlorophyll metabolism, photosynthesis and sugar metabolism. SlARF6 protein directly bound to the promoter of SlGLK1, CABs and RbcS genes and positively regulated the expression of these genes. *SlARF6* also played a role in the regulation of fruit ripening and ethylene production, by directly binding to SAMS1 promoter and negatively regulated the SAMS1 expression. Taken together, our study demonstrates that ARFs play an important role in the regulation of chlorophyll biosynthesis, photosynthesis, sugar accumulation and fruit development in tomato and provides a potential target for genetic engineering to improve fruit nutrition in horticulture crops.

2:15 PM – 2:30 PM

Novel Environmentally Friendly Supercritical Fluid with Carbon Dioxide (SC-CO_2) Extraction, Identification, and Quantification of Polyprenols, As Health Promoting Bioactives from Plant Tissues.

Hadil Alaydi*, Limerick Institute of Technology

Polyprenols, are a long-chain isoprenoid alcohols with the formula (C5H8)n. In the human body, polyprenols are transformed into dolichols, which play a significant role in immune function, liver regeneration, suppression of cancer, antimicrobial and antiviral activity and Alzheimer's disease prevention. Polyprenols are promising compounds for pharmaceutical sector. The aim of this study to develop supercritical carbon dioxide ($SC\text{-}CO_2$) extraction of polyprenols and other bioactive compounds (antioxidants, polyphenolics and flavonoids) from needles of *Picea pungens* (blue spruce), *Taxus bacatta* (Irish yew), *Pinus sylvestris* (Scots pine) and leaves of *Sorbus aucuparia* (mountain ash). The $SC\text{-}CO_2$ extraction is a clean and environmentally friendly alternative to traditional solvent methods as it eliminates the use of toxic organic solvents and the expensive post-processing solvent elimination from the extracts. The experimental orthogonal array design L_{24} (4^5) was applied to optimise the $SC\text{-}CO_2$ extraction conditions: pressure (100–350 bar), temperature (40–70°C), percentage of modifier (ethanol absolute) and extraction time (up to 70 min). $SC\text{-}CO_2$ extraction of polyprenols was performed on *P. pungens* which were used as a model plant for optimisation. The $SC\text{-}CO_2$ extracts were compared with conventional solvent extracts (hexane/acetone, 1:1 and 4:1 v/v, and 70% ethanol). The detection and identification of polyprenos was performed by HPLC. Polyprenols were detected in *P. pungens, P. sylvestris* and *S. aucuparia* but not in *T. bacatta*. *P. sylvestris* was identified as the most promising source of polyprenols: it had the highest concentration of polyprenols with the widest range of isoprene oligomeric units. The $SC\text{-}CO_2$ extraction was an effective and promising method for the extraction of polyprenols. The higher yield of polyprenols were extracted by SC-CO then by traditional solvent extractions. Furthermore, wider range of short- and medium-chain polyprenol oligomers were observed in $SC\text{-}CO_2$ extracts. The optimum $SC\text{-}CO_2$ extraction conditions were also established. *P. pungens*, *T. bacatta*, *P. sylvestris* and *S. aucuparia* solvent and $SC\text{-}CO_2$ extracts were also analysed for the phenolics, flavonoids and antioxidants compounds. Antioxidant properties were evaluated by DPPH and FRAP assays. The extraction with 70% ethanol was identified as the most effective solvent for these bioactive compounds. All four plants demonstrated high level of bioactivities, with *P. sylvestris* having the highest concentration of phenolic, flavonoids and antioxidant. $SC\text{-}CO_2$ was not a very effective method for the extraction of phenolic, flavonoids and antioxidant compounds and in average ten times less effective than the extraction with 70% ethanol.

Propagation

Moderator: Sandra B. Wilson
University of Florida, Gainesville, FL, USA

2:00 PM – 2:15 PM

Propagation of *Helianthus Verticillatus*, the Whorled Sunflower

Robert N. Trigiano, University of Tennessee - Knoxville; Christopher Wyman, University of Tennessee; Sandra B. Wilson*, University of Florida and Carlee Steppe, University Florida

Helianthus verticillatus or whorled sunflower was recently designated an endangered species and grows only on a few prairie remnant sites in Tennessee, Georgia, and Alabama. This perennial species spreads locally by rhizomes and more distantly by seeds dispersed by foraging birds. Because few details about the reproductive biology of this species are known, our specific aims were to evaluate seed viability, assess temperatures conducive for seed germination, and develop methodologies for clonal, vegetative propagation. More than 98% of seeds collected in 2017 and stored dry at room temperature were viable after seven months. Only 77% of the seeds in the high-temperature treatment (33 C) germinated within 28 days, whereas, 96% of seeds in the other three regimes (22, 27, and 29 C) germinated. About half of the seed in the coldest treatment germinated within 7-8 days, whereas 50% germinated within 1-2 days in the three warmer treatments. Many of the leaf and node explants placed in culture became contaminated within two weeks. Axillary buds elongated on medium with or without cytokinins, but excised shoots failed to produce roots. Very few shoots were formed on excised leaves placed on medium containing various cytokinins. Almost all of the terminal cuttings harvested in late May formed robust root systems after four weeks, grew well and flowered normally in September. Only about 20% of the three node cuttings (without terminal buds) harvested in late June produced roots in response to either water of auxin treatments. We concluded from these experiments that whorled sunflower could be efficiently and effectively propagated from either seeds or terminal bud cuttings stuck in May.

Specified Source(s) of Funding: USDA NACA 58-6062

2:15 PM – 2:30 PM

Strategic Approaches to Propagate Small Fruit Crops in Bioreactor Systems Containing a Liquid Medium

Samir C. Debnath*, Agriculture and Agri-Food Canada

Small fruit crops including the species in genera *Vaccinium* (blueberry, cranberry and lingonberry; Ericaceae), *Fragaria* (strawberry; Rosaceae), and *Rubus* (brambles: raspberry and blackberry; Rosaceae) are healthy fruits that have anti-oxidant, anti-tumor, anti-ulcer, and anti-inflammatory activities. Although substantial improvement in small fruit micropropagation has been achieved in temporary immersion and stationary bioreactor systems, somaclonal variation (genetic and epigenetic) are an important concern in commercial production. Both bioreactor systems are efficient in small fruit micropropagation, although the use of Growtek bioreactors are more cost effective. This presentation deals with in depth discussion of various bioreactor micropropagation systems, molecular markers to verify clonal fidelity, and morphological, biochemical, and genetic/epigenetic variations in small fruit micropropagules. The possible role of epigenetic variation in small fruit crop production has also been described.

2:30 PM – 2:45 PM

Thidiazuron Concentration, Explant and Carbon

Source on Regeneration of *Paulownia Elongata* sy Hu.

Richa Bajaj*[1]; Lubana Shahin[2]; Brajesh Vaidya[2]; Donglin Zhang[1] and Nirmal Joshee[2], (1)University of Georgia, (2) Fort Valley State University

Paulownia elongata is a fast-growing multipurpose tree. To assist commercial mass production, two week old rootless seedlings were placed in normal and inverted orientation in Murashige and Skoog (MS) and Gamborg's B5 media (B5) with two carbon sources (30 or 40 g/L) and thidiazuron (TDZ) (25 µM) + Indole acetic acid (IAA) (5 or 10 µM) for shoot induction. Explants in normal orientation produced up to 39 shoots per explant after ten days in shoot induction medium, while only 28 and 12 for five and three days. For inverted explants, the shoot induction pattern was similar with respect to the induction days but number of shoots was much higher to 50, 47, and 37 in ten, five, and three days. For normal orientation explants, treatments MS+ 25 µM TDZ+5 µM IAA+maltose (40 g/L), B5+25 µM TDZ+5 µM IAA+maltose (40 g/L), and B5+25 µM TDZ+5 µM IAA+sucrose (30 g/L) with ten days shoot induction period resulted in high shoot numbers with no significant difference among three treatments. For inverted orientation explants, the medium, B5+25 µM TDZ+10 µM IAA+sucrose (30 g/L), for ten days should be recommended. Vegetative buds from mature trees were used as explants to develop in vitro stock in comparison with juvenile seedlings. After three weeks, nodes and petiole with half leaf were used as explants in B5 medium supplemented with TDZ (25 µM) and IAA (5, 10 or 25 µM) and maltose as carbon source (40 g/L). The highest number of shoots produced from nodes were 110 and 77 from petiole with half leaf. Petiole with half leaf was more responsive as compared to nodes. Heatmaps were generated to track the progress of each explant. Histological studies and scanning electron microscopy were used to document initiation of meristematic cells and shoot meristems. Elongated shoots with one to five nodes were transferred to MS basal and MS+5 µM IBA resulting in 100% rooting. Acclimated plants were successfully transferred to the greenhouse and had 60% and 70% survival rate for MS and MS+5 µM IBA respectively.

2:45 PM – 3:00 PM

Interspecific Variation of Seed Dormancy in Four *Lonicera* species Native to Korea

Hyung Bin Park[1]; Chung Ho Ko[1]; Balkrishna Ghimire[1]; Seung Youn Lee[2]; Jong Cheol Yang[1]; Jae Hyun Kim*[1]; Sang Yong Kim[1] and Ki Cheol Lee[1], (1)Division of Plant Resources, Korea National Arboretum, Korea Forest Service, (2)Division of Plant Resources, Korea National Arboretum, Korea Forest Service (Current address:Division of Horticulture & Medicinal Plant, Andong National University)

Seed dormancy type and germination characteristics of four Korean native *Lonicera* species (*Lonicera insularis* Nakai, *Lonicera praeflorens* Batalin, *Lonicera harae* Makino and *Lonicera subsessilis* Rehder) were investigated. Imbibition test of the seeds was conducted, and the seeds were incubated at constant temperatures of 5, 15, 20, or 25ºC. Embryo morphology was observed at seed dispersal and just before germination. Because seeds of four *Lonicera* species imbibed water readily, they have no physical dormancy (PY). Four *Lonicera* species had underdeveloped embryos with length of 0.13-0.26mm at dispersal. The embryos were grown to critical length of 0.46-0.81mm just before germination. Freshly matured seeds of *L. insularis* Nakai and *L. harae* Makino germinated over 90% at 15 and 20ºC respectively within 4 weeks after sowing. On the other hand, no germination of *L. pareflorens* Batalin and *L. subssesilis* Rheder was observed within 4 weeks after sowing at all temperature treatments. Therefore, *L. insularis* Nakai and *L. harae* Makino have only morphological dormancy (MD) and *L. pareflorens* Batalin and *L. subssesilis* Rheder have morphophysiological dormancy (MPD). At 15ºC, the germination of *L. praeflorens* Batalin started on the fifth week after sowing and completed on the ninth week with the final germination rate of 52.2%. Seeds of *L. subsessilis* Rheder began germinating on the fifth week after sowing at 15ºC and on the fourteenth week where the germination was complete, the final germination rate were 80.0%. Embryo growth and germination of *L. praeflorens* Batalin and *L. subsessilis* Rheder were occurred at relative high temperature (≥15ºC). Thus, seeds of *L. praeflorens* Batalin and *L. subsessilis* Rheder have non-deep simple type MPD that dormancy breaking and embryo growth require only relative high temperature (≥15ºC). Optimum temperature for germination of seeds of *L. insularis* Nakai and *L. harae* Makino was 15ºC and *L. praeflorens* Batalin and *L. subsessilis* Rheder was 20ºC. The dispersal patterns of seeds in habitat correspond with germination characteristics and seed dormancy type. These results could be useful to study eco-physiological mechanisms of *Lonicera* species.

Specified Source(s) of Funding: (KNA1-2-25, 16-3) project funded by Korea National Arboretum.

3:00 PM – 3:15 PM

Pine and Sugarcane Biochar As Container Media Amendments for Seedling Production of Tomato (*Solanumlycopersicum*) and Basil (*Ocimum basilicum*)

Ping Yu*, Taxes A&M University

Biochar (BC) can be an excellent alternative of peat moss as greenhouse media with similar effects on container plants. The objective of this study was to investigate the effects of pine bark biochar (PBC) and sugarcane biochar (SBC) mixed with peat moss at different rate (10%, 30%, 50% and 70% PBC with the rest being peat moss, or 10% , 30%, 50% and 70% SBC with 30% perlite and the rest being peat moss, by volume) on container tomato and basil growth, compared to control (70% peat moss and 30% perlite) and a commercial mix. A phytotoxicity test was conducted with water extraction of each of the mixes and the deionized water was used as control. Only basil seeds were used and the final germination rates were used as indications of phytotoxicity. Tomato and basil seeds were sown in one of the mixes and their germination rates were recorded for 3 weeks. The seedlings were allowed to grow for another week and at the end of experiment, all seedlings were harvested to measure fresh weight and dry weight and the roots were washed and root length, root area, the number of tips were measured by using root scanner. The effects of biochar on tomato and basil vary among biochar types and rates. There was no difference among the mixes for the phytotoxicity test. There was no significant difference for tomato plants among the mixes on survival except for plants grown in 100% PBC, which had significant lower survival rate and for plants grown in 10% of PBC, which had significant higher survival rate compared to control. Basil plants grown in 100% SBC, 10% PBC, 70% PBC and 100% PBC had significant difference from control on survival. PBC can replace peat moss without addition limestone as greenhouse media amendment up to 70% and 50% for seedling production of tomato and basil plants.

3:15 PM – 3:30 PM

Peach Biotechnology Research to Develop Reproducible Protocol for Micropropagation

Bipul Biswas*, Fort Valley State University

± 2 ºC, under continuous dark or under a photoperiod of 16 h light and 8 h dark depending on the objective. Leaves were incubated in continuous dark for three-weeks until it was transferred to light conditions. Nodal segments treated with mercuric chloride at 0.5 % concentration for 20 minutes had the highest explant survival percent (86 ± 0.07) and the lowest amount of browning. We observed the bud break was 0.57 ± 0.04 at 0.1% $HgCl_2$ for 20 min. Nitsch (NB) and modified NB medium supplemented with 1.0 mg/L BAP and 0.5 mg/L Kinetin supported for better responses. Callus, root induction, and a few somatic embryos were observed. The peach tissue culture is more difficult to develop a successful protocol than any other woody fruit tree was investigated. The comparison will be presented.

Specified Source(s) of Funding: NIFA (Station Project)

Citrus Crops 1

Moderator: Tripti Vashisth
University of Florida, Lake Alfred, FL, USA

2:00 PM – 2:15 PM

Manipulating Flowering with the Use of Gibberellins in Huanglongbing-Affected Sweet Orange

Tripti Vashisth*[1]; Garima Singh[1]; Lisa Tang[1] and Megan Dewdney[2], (1)University of Florida, (2)Citrus Research and Education Center, University of Florida

Huanglongbing (HLB)-affected trees often display prolonged flowering period. Typically, in Florida, the flowering period in sweet oranges expands from late-January to mid-April with multiple waves of bloom. Such extended period of flowering results in difficulty for grove management especially, for the management of flower-associated fungal pathogens such as *Colletotrichum acutatum,* the causal agent for postbloom fruit drop (PFD). Gibberellins (GA) are well known to suppress flowering in citrus trees. Therefore, it can be a useful tool to manipulate flowering for better disease management. Hence, the objective of this study was to evaluate the potential of GA in synchronizing flowering in HLB-affected sweet orange cultivar Valencia. Trees were applied with GA five times from September to January at the rate of 20 g active ingredient per acre with surfactant and were compared to trees treated with surfactant only. The experiment was replicated at two separate locations, known to have close to 100% HLB infection and the history of PFD. The GA application resulted in a 55 to 60% reduction in floral intensity and a shift of full bloom by almost 2 weeks compared to untreated control trees. The flowering in GA-treated trees was more synchronized, with all the flowering activity occurring in period of 4 weeks whereas the flowering in control trees spread for about 6-7 weeks. Overall, the results of this research suggest that GA can be effectively used to alter the flowering pattern to benefit grove management.

2:15 PM – 2:30 PM

Tree Density and Micronutrient Application on Grapefruit Affected By Huanglongbing.

Dinesh Phuyal*[1]; Rhuanito S. Ferrarezi[2]; Davie Kadyampakeni[2] and Kelly T. Morgan[2], (1)University of florida, (2) University of Florida

Citrus greening or Huanglongbing (HLB) disease is a serious threat to citrus production in Florida. Since a cure is still unknown, disease management is necessary to maintain trees in production. Management strategies rely on different approaches: controlling the insect vector, applying antimicrobials and enhance plant nutrition to extend tree survival. We are conducting a field trial on 5-year-old 'Ray Ruby' grapefruit (*Citrus paradisi*) on Kuharske citrange (*Citrus sinensis·× Poncirus trifoliata*) rootstock planted in the Flatwoods soils in Fort Pierce, FL. The objective is to understand how tree spacing, soil and foliar fertilization affect fruit yield and fruit quality on HLB-infected grapefruit trees in the Indian River citrus district. We tested three planting densities [standard spacing (300 trees/hectare), high-density single row (440 trees/hectare), and high-density double row staggered in diamond setting (975 trees/hectare)], two soil application blends of controlled-release fertilizer (CRF) (16N-1.31P-16.6K and 12N-1.31P-7.47K plus higher micronutrient rate), and four foliar rates of micronutrient (a blend of Mn, Zn, and B at 0×, 1×, 3×, and 6× IFAS recommendation). All the trees tested positive for HLB based on real-time quantitative PCR test. The preliminary results indicate the highest yield was obtained with high-density double row staggered at 170 boxes of 38.5 kilograms per hectare (P<0.001). Canopy volume was 43% higher with standard spacing than high-density double row staggered (P<0.0001). Trunk diameter was 2.3% larger on standard tree spacing than high-density double row staggered with no effect of nutrient treatment (P<0.0001). Fruit with high-density double row staggered were more acidic (average titratable acidity 1.16 mg/100 mL) than other treatments irrespective of the nutrient application (P<0.0001). Soluble solids content was 5.75% higher on high-density double row staggered trees than standard spacing (P=0.0278) with no effect of nutrient treatment. There was no effect on yield by both CRF formulations (P=0.8428) and foliar treatment (P=0.7126) in the first year. The 12N-1.31P-7.47K increased the canopy volume by 8% (P<0.0001). Canopy volume remained unaffected by foliar treatment (P=0.3782). Leaf nutrient concentration increased with the increase in foliar rate for all micronutrients, particularly Mn (P<0.0001) that exceeds the optimum range with 6× application of IFAS rate. The study shows that high-density double row staggered results in higher yield with lower canopy volume. CRF blends with higher micronutrients can contribute to greater canopy growth without increasing fruit yield. Foliar treatment of micronutrients can maintain tree health by improving nutrients status of the plant.

Specified Source(s) of Funding: UF/IFAS Citrus Initiative.

2:30 PM – 2:45 PM

Assessment of Mature Fruit Drop in Huanglongbing-Affected Sweet Orange and ‘Sugar Belle’ Mandarin Trees

Lisa Tang* and Tripti Vashisth, University of Florida

In Florida, it has been documented that Huanglongbing [HLB (*Candidatus* Liberibacter asiaticus)] elevates preharvest fruit drop in affected citrus trees, especially for sweet orange (*Citrus sinensis*) cultivars. In contrast, the mandarin hybrid ‘Sugar Belle’ (previously known as ‘LB8-9’) [*Citrus reticulata* × (*C. paradise* ×*C. reticulata*)], which was released by the Citrus Research and Education Center, University of Florida/IFAS (Lake Alfred, FL) in 2009, is tolerant to HLB and has relatively low preharvest fruit drop. To increase our understanding of the mechanism that causes the various tendencies of preharvest fruit drop for different citrus in the presence of HLB, the objective of this study was to analyze the global transcriptome of abscission zones (AZ) from mature fruit of field-grown HLB-affected sweet orange and ‘Sugar Belle’ mandarin trees. For the citrus used in the experiment, a set of mature fruit were left on trees (unharvested) during commercial harvest for the evaluation of fruit drop. The fruit drop rate of ‘Midsweet’ sweet orange was 8% at 2 weeks after the commercial harvest day (WAH) and reached 25% at 4 WAH; ‘Hamlin’ sweet orange had 23% of fruit dropping at 2 WAH and more than 30% at 4 WAH. In contrast, for ‘Sugar Belle’ mandarin, the drop rate remained below 8% within 5 WAH. The results indicate that ‘Hamlin’ sweet orange had a higher tendency to drop than ‘Sugar Belle’ mandarin as early as 2 WAH. For the mature fruit that were likely to abscise [fruit detachment force (FDF) < 5.5 kgF], there were only 26 differentially expressed genes (DEGs) in the AZ of ‘Hamlin’ sweet orange compared to ‘Sugar Belle’ mandarin at 2 WAH. For the fruit inclined to retain on the tree (FDF > 5.5 kgF), there were 125 DEGs between the two citrus. The extremely low number of DEGs (less than 1% of total mapped reads) in the two contrasts suggest that the underlying biochemical and physiological mechanism of mature fruit abscission is highly conversed among citrus species with different tendencies of preharvest fruit drop and with different susceptibility to HLB.

2:45 PM – 3:00 PM

Physiological Effects of Oak Bioactive Extracts to Contain and Suppress HLB Disease on Citrus

Lorenzo Rossi*[1]; Marco Pitino[1]; Christina Dorado[2]; Robert Shatters Jr.[2] and Liliana M. Cano[1], (1)University of Florida, (2)USDA-ARS

Huanglongbing (HLB) is rapidly destroying the Florida Citrus industry. To date, plant treatments and attempts to develop sustainable management practices have only provided modest improvements in controlling the disease impact on plant health and yield. Consequently, there is an urgent demand for innovative methods/strategies to look for HLB cures. Since plants produce an array of complex chemical substances (*i.e.,* secondary metabolites) they are considered new resources for producing agents that could act as alternatives to antibiotics in the treatment of the causative agent (*Candidatus* Liberibacter asiaticus, *C*Las). Particularly, secondary metabolites form new sources of antimicrobial molecules to use against *C*Las. Since, the literature is replete with articles on identification and characterization of antimicrobial compounds in oak, the present study was aimed at screening the antibacterial properties oak leaf (*Quercus laurifolia*) extracts. Nine sweet oranges (*Citrus × sinensis* ‘Valencia’) grafted on ‘Volkamericana’ rootstock grown in the USDA-ARS greenhouse in Fort Pierce, FL, USA were employed. Six individual 1-year-old healthy plants were graft-inoculated via side-grafting with *C*Las-positive sweet orange bud sticks while 3 individuals were kept uninfected as control. Ct values corresponding to *C*Las titer from qRT-PCR were used to confirm that plants were either healthy or *C*Las-infected. After HLB infection was confirmed 3 individuals were chosen and treated with root drench and foliar intended spray applications (twice per week for 2 months) of oak leaf extract. This extract was prepared by macerating the oak leaves in distillated water and allowing to set overnight. After 6-month treatments a series of physiological parameters (*i.e.*, stomatal conductance, chlorophyll contents, starch accumulation, electrolyte leakage), as well as nutrient content (N, P, K) and *C*Las titer, were measured. Additionally, a biochemical composition of the oak leaf extracts was also performed. As a result, the oak-treated plants overcome the infection and restored their physiological and nutritional levels which resulted in the same ranges of the healthy plants, while the un-treated plants showed classic HLB symptoms.

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3:00 PM – 3:15 PM

Effect of Irrigation Water pH on Performance of HLB-Affected Citrus Plants

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Huanglongbing (HLB) is one of the most devastating diseases in citrus (*Citrus* spp.) with roots being the first and foremost site of pathogen colonization. Field observation suggest that the HLB-affected root system debilitates quickly in response to high soil pH. Soil pH of the root zone directly affects nutrient availability and influences root health indicating possibility of interaction with HLB. Therefore, the objectives of this experiment were to evaluate the performance of healthy and HLB-affected citrus plants irrigated with water at different pH ranges and to investigate the molecular regulation of such response. Healthy and HLB-affected 'Midsweet' sweet orange (*Citrus sinensis*) grafted on Kuharske citrange (*C. sinensis X P. trifoliata*) were used in this study. Plants were arranged in completely randomized design with 4 replicates and were irrigated every 2-3 days with sodium phosphate buffers at pH 5.8, 7.0 and 8.0. Plant performance was monitored for a period of 60 days. HLB-affected plants at pH 8 had the highest death rate of about 40% compared to the 100% survival rate at pH 5.8. HLB-affected plants at pH 5.8 showed about 6.6% increase in plant height while at pH 8.0 the increase was 0.78%. At pH 8.0, HLB-affected plants showed leaf drop of more than 80% and leaf fresh weight of about 0.25 g, while healthy plants showed leaf drop of about 60% and leaf fresh weight of about 14.75 g. Compared to the healthy plants, soil-media of HLB-affected plants had higher electrical conductivity (EC) at pH 8.0, thus indicating poor uptake of nutrients. There was the highest uptake of Zn and the least uptake of Ca at pH 8.0 among the HLB-affected plants. Leaf chlorophyll content decreased with increase in pH. Severity of HLB symptoms varied in relation to different irrigation pH and symptoms were more prominently expressed at pH 8.0 than at pH 5.8. Among all treatments, HLB-affected plants at pH 8.0 had the most limited root growth and development pattern, leading to the lowest root dry weight. In contrast, pH 5.8 treatment did not affect HLB-affected plants when compared to healthy ones. Transcriptomic analysis of leaf and root tissue is underway to understand the interaction between pH and HLB. The physiological results of this study suggest there is an interaction between HLB and soil pH, where HLB symptoms exacerbates under high pH conditions. Therefore, regulation of irrigation water pH can potentially minimize the symptom and effects of HLB.

3:15 PM – 3:30 PM

US Sundragon: Huanglongbing Tolerant Citrus Scion with *Poncirus* in Its Pedigree

Ed Stover*[1]; Randall Driggers[2]; Greg McCollum[3]; Elizabeth A. Baldwin[1]; Jinhe Bai[1]; Anne Plotto[1] and Jose X. Chaparro[4], (1)USDA-ARS, (2)USDA/ARS, (3)USDA ARS USHRL, (4)University of Florida

The disease huanglongbing (HLB) has devastated the Florida citrus industry, and HLB-tolerant planting material will likely be key to sustaining its continued existence. Potentially useful tolerance to infection by the HLB pathogen (hereafter "HLB-tolerance") has been identified in some mandarin hybrids, and in some hybrids with the highly tolerant Poncirus trifoliata in their pedigree. The USDA/ARS citrus breeding program has been making crosses with Poncirus for over a hundred years, primarily to introgress cold hardiness and disease resistance into conventional citrus. Currently, many of the most widely grown citrus rootstocks are Poncirus hybrids. However, scion cultivars derived from Poncirus have been previously released only as breeding parents, as early generation hybrids have a very unpleasant flavor. Scion breeders have continued to work with Poncirus, some of these hybrids fortuitously display remarkable HLB-tolerance, and one of these hybrids has just been released as US SunDragon. US SunDragon is derived from a cross made by José Chaparro in 1999 of two complex hybrid selections, one of which has two Poncirus grandparents, resulting in a pedigree that is 1/8 Poncirus trifoliata. Seedling trees were planted at the USDA St. Lucie County FL farm in 2000 and US SunDragon was selected in 2011. US SunDragon has been planted at many sites, including replicated trials, and has shown remarkable HLB tolerance at all sites. The fruit is mature from Oct-Jan in Florida, reaching 11% soluble solids content (SSC) by Oct. During the period of optimal maturity, SSC ranges from 11-15% and titratable acidity from 0.4-0.8%. Color score is low at 33-34. If harvested early, some people note a slight off-taste, which diminishes as fruit mature. US SunDragon has been well-received in consumer taste panels, with fruit and juice most similar to sweet orange. Fruits have a pyriform shape, a distinctive pebbly skin, and green color is usually retained at the stem end of the fruit. US SunDragon is a valuable monoembryonic breeding parent, and has good potential for niche uses by local markets, gift-fruit-shippers, and home orchardists. Dooryard citrus trees have become uncommon in Florida as trees have died or become unproductive due to HLB. We anticipate that US SunDragon will be productive and healthy in a dooryard environment with a relatively low level of care, even in areas where HLB is endemic. Recently US SunDragon has received considerable interest as a potential contributor to commercial juice blends as production of sweet orange declines.

Specified Source(s) of Funding: USDA Base funding, New Varieties Development and Management Corporation, NIFA-SCRI, Citrus Research and Development Foundation

3:30 PM – 3:45 PM

Comparative Transcriptome Analyses between the HLB Tolerant Australian Finger Lime and HLB Susceptible Valencia Sweet Orange

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Huanglongbing (HLB) is a phloem limited bacterial disease caused by *Candidatus* Liberibacter asiaticus (*C*Las). This disease has devastated the Florida citrus industry and is spreading to other citrus growing parts of the USA. The citrus relative, *Microcitrus australasica* (Australian finger lime) has been observed to be tolerant to the disease under endemic HLB conditions while commercial sweet oranges such as 'Valencia' are not. To better understand the mechanism of tolerance to HLB, a greenhouse infection study was conducted with the finger lime DPI-50-36 and 'Valencia' SPB-1-14-19 sweet orange trees. Both scions were budded onto carrizo rootstock and 6-month old trees were side grafted with 6-inch-long HLB infected sweet orange bud sticks. HLB disease progression was monitored on a quarterly interval using qPCR. Both finger lime and 'Valencia' trees tested positive for *C*Las within 6 months of grafting. Finger lime trees however had a lower population of the bacterium in the phloem and remained visually symptom free even after 1 year following infection. On the other hand, 'Valencia' trees developed HLB symptoms within 9 months following infection. RNA samples were extracted from leaves of one-year old infected trees and sequenced using the Illumina HiSeq platform with a 2x150bp configuration. Analyses between the finger lime infected and control resulted in the identification of 2919 differently expressed genes, of which 1520 were down regulated in the infected group, while 1399 were up regulated. Similar analyses between the infected and control 'Valencia' resulted in 335 differently expressed genes, of which 96 were down regulated in the infected group, while 239 were up regulated. Gene ontology analyses revealed that cell wall components and cell wall supports (microtubules) where down regulated in both infected groups, while heme binding and oxidoreductase activity were overexpressed. In addition to a number of defense related genes (PR, TIR-NBS-LRR, NAC families), several primary and secondary metabolism genes as well as genes responsible for nutrient transport were highly upregulated in the infected finger lime trees. Defense and nutrition related genes were down regulated in infected 'Valencia' trees. Our results provide a novel insight into the potential mechanism of HLB tolerance in finger limes.

Growth Chambers and Controlled Environments 3

Moderator: Kellie J. Walters
Iowa State University, Ames, MI, USA

2:00 PM – 2:15 PM

Growth and Morphological Responses of Digitalis and Rudbeckia Seedlings to Supplemental Far-Red LED Light

Claudia A. Elkins*; Michael Martin and Marc W. van Iersel, University of Georgia

A large fraction of far-red light can signal plants that they are shaded by other plants and can induce a shade-avoidance response, such as increased elongation or larger leaves. Larger leaves increase light interception, which may increase photosynthesis and growth. In addition, far-red light can increase the efficiency with which plants use light of shorter wavelengths for photosynthesis. We thus hypothesized that supplemental far-red light can increase the growth of seedlings grown under white LED light, potentially shortening the production time, and increasing profits for growers. *Digitalis purpurea* 'Dalmatian Peach' and *Rudbeckia fulgida* 'Goldsturm' seedlings were grown in a 54 m^3 walk-in cooler converted into a walk-in growth chamber. The chamber contained three shelving units each divided into six 1.2 m × 0.6 m growing sections. Each section was equipped with two white LED light bars. Fifteen sections received anywhere from 7.9 to 68.8 $\mu mol\ m^{-2}\ s^{-1}$ of supplemental far-red light, while three sections received no supplemental far-red. Eighteen 72-cell trays were sown with *Rudbeckia* and eighteen sown with *Digitalis.* One tray of each species was placed in each growing section. Plants were grown at 21.5 ± 0.2 °C, with a 16-hr photoperiod, photosynthetic photon flux density of 186 ± 6.4 $\mu mol\ m^{-2}\ s^{-1}$, daily light integral of 10.7 ± 0.4 $mol\ m^{-2}\ d^{-1}$, mean vapor pressure deficit of 1.3 ± 0.1 kPa, and CO_2 concentration of 800 ± 15 ppm (mean ± standard deviation). The plants were regularly fertigated using an ebb-and-flow system. Data were analyzed using linear regression. The addition of far-red light increased *Digitalis* shoot dry weight 38% (P=0.004), root dry weight 22% (P=0.029), and shoot length 38% (P = 0.025) in a dose-dependent manner. The root fraction of *Digitalis* decreased 21% (P = 0.034) with increasing far-red. The *Rudbeckia* seeds were slow to germinate and germination was not uniform. However, we were able to harvest ten plants per treatment. As far-red light levels increased, the specific leaf area of *Rudbeckia* decreased (P= 0.004), not a typical shade response and not what we expected. Overall, we found a positive correlation between seedling growth and the intensity of supplemental far-red light. These findings may lead to better use of supplemental light to optimize production of perennial seedlings.

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2:15 PM – 2:30 PM

Morphological and Physiological Screening for Growth Differences Among 11 Lettuce Cultivars

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A rapid screening test for fast growth can facilitate cultivar development and selection for controlled environmental agriculture. An ideal screening method can rapidly and non-invasively detect desirable phenotypes, based on physiological and/or morphological characteristics. We developed a screening protocol by testing a combination of canopy imaging and chlorophyll fluorescence-light response curves. Ten plants of 11 lettuce cultivars (*Lactuca sativa*; 'Aquino', 'Barlach', 'Carmessi', 'Crunchita', 'Locarno', 'Lotus', 'Rex', 'Rouxai', 'Seurat', 'Teodore', and 'Xandra') were planted in 0.5 L pots containing a soilless substrate. Plants were subirrigated with hydroponic solution containing 100 $mg \cdot L^{-1}$ of nitrogen. The greenhouse conditions averaged a daily light integral of 8.9 ± 9.6 $mol \cdot m^{-2} \cdot d^{-1}$, temperature of 23.4 ± 1.2 °C, and relative humidity of 38 ± 13% (mean ± SD). Projected canopy size (PCS), as determined using canopy imaging, differed both among cultivars and at different days after germination (DAG). Dry weights (DW) at 51 DAG were measured to identify a correlation with measured parameters. PCS at 13 DAG explained 52% of variability in final DW among cultivars. At 24, 34, and 48 DAG, the coefficient of determination was 0.12, 0.61, and 0.66, respectively. 'Lotus' had the highest PCS throughout the experiment and also had the highest DW. Sigmoidal regression of the cumulative photosynthetic photon flux density (*PPFD*) versus PCS characterized different growth patterns among cultivars. The asymptote of the sigmoidal curve was positively correlated with final DW (R^2 = 0.60), indicating that a large PCS is associated with greater final DW. Diurnal chlorophyll fluorescence responses to *PPFD* showed different photochemical efficiencies [the quantum yield of photosystem II (Φ_{PSII}) and electron transport rate (ETR)] among cultivars. The PCS at 13 DAG combined with the maximum ETR explained 80% of variability in DW among cultivars. Total canopy photochemistry (TCP; mol) over the cropping cycle of the cultivars was estimated from the *PPFD*, the ETR responses ($\mu mol \cdot m^{-2} \cdot s^{-1}$) to *PPFD*, and the PCS (m^2). Because the presence of anthocyanins may lead to an overestimation of ETR, regression between estimated TCP and DW was done separately for green and purple lettuces. TCP and DW of green lettuces were highly correlated (R^2 = 0.96), but purple lettuces showed no such correlation. In conclusion, screening of phenotypes for greater biomass production can be accomplished based on PCS and chlorophyll fluorescence-light response curves. However, chlorophyll fluorescent measurements may not be useful for anthocyanin-rich cultivars.

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2:30 PM – 2:45 PM

Consumer Sensory Preferences in Response to Manipulating Fresh Basil Flavor through Controlled Environment Light, Temperature, and Carbon Dioxide Management

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Light intensity, average daily temperature (ADT), and carbon dioxide (CO_2) concentration can influence the growth and development of crops. However, altering environmental parameters in controlled environments (CE) can also influence the sensory attributes of culinary herbs. This may result in a diversity of consumer taste preferences. Therefore, our objectives were to 1) determine if consumers can detect differences in basil flavor due to light intensity, CO_2 concentration, and ADT and 2) characterize their preferences to better inform production and marketing strategies. Thus, we conducted three consumer taste panels. For experiment 1, seeds of basil (*Ocimum basilicum*) 'Nufar' were sown and placed in a growth chamber under light intensities of 100, 200, 400, or 600 $\mu mol \cdot m^{-2} \cdot s^{-1}$ with a 16-h photoperiod creating daily light integrals (DLIs) of 6, 12, 23, and 35 $mol \cdot m^{-2} \cdot d^{-1}$. After two weeks, leaves were harvested for evaluation. In experiment 2, seeds were sown and placed in growth chambers under light intensities of 200 or 400 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and 500 or 1,000 $\mu mol \cdot mol^{-1}$ CO_2 with leaves harvested after two weeks. For experiment 3, seedlings were transplanted into deep-flow hydroponic systems in greenhouses with target ADTs of 23, 26, 29, 32, or 35 °C and grown for three weeks, after which the four most newly mature leaves were harvested. Panel evaluations were conducted through a sliding-door with samples served individually while panelists answered Likert scale and open-ended quality attribute and sensory questions. Over all, consumers preferred basil grown under a 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ light intensity the most because these samples had a less bitter taste, milder aftertaste, deeper green color, crisper texture, more moderate flavor, and more pleasant aroma. However, panelists preferred the larger leaf size of basil grown under 400 and 600 $\mu mol \cdot m^{-2} \cdot s^{-1}$ compared to plants grown under 100 or 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Consumers indicated no differences in flavor between the CO_2 treatments. However, they preferred the appearance, texture, and color of basil grown under higher ADTs (26 or 29 to 35 °C) compared to 23 °C due to the smaller leaf size of plants grown at higher ADTs, the more crisp texture, and the deeper color. However, plants grown with an ADT of 23 °C were less bitter than those grown at 35 °C; so overall liking between temperature treatments was not different. Therefore, consumer preferences should be considered and incorporated into CE production and marketing decisions.

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2:45 PM – 3:00 PM

Investigating the Merit of Including Green and Far-Red Radiation in Plant Growth of Lettuce and Tomato Under Sole-Source Lighting

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Green (G, 500 to 600 nm) radiation is often considered less effective at driving photosynthesis than red (R, 600 to 700 nm) radiation. In addition, far-red (FR, 700 to 800 nm) radiation is regarded as inefficient at directly promoting photosynthesis. However, G and FR radiation induce shade-avoidance responses including promotion of extension growth that increases radiation capture. Here we investigated how substituting G with R radiation influenced plant growth with and without FR radiation. We grew young plants of lettuce (*Lactuca sativa*) and tomato (*Solanum lycopersicum*) indoors under lighting from light-emitting diodes in a controlled-environment growth room at 22 ºC. All lighting treatments provided a photosynthetic photon flux density of 180 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for $18 h \cdot d^{-1}$ with the following photon flux densities (subscript in $\mu mol \cdot m^{-2} \cdot s^{-1}$) of blue (B, 400 to 500 nm, peak=448 nm), G (peak=527 nm), R (peak=662 nm), or/and FR (peak=734 nm) radiation: $B_{60}G_{60}R_{60}FR_{60}$, $B_{60}G_{30}R_{90}FR_{60}$, $B_{60}G_{15}R_{105}FR_{60}$, $B_{60}G_{6}R_{114}FR_{60}$, $B_{60}R_{120}FR_{60}$, $B_{60}G_{60}R_{60}$, $B_{60}G_{30}R_{90}$, $B_{60}G_{15}R_{105}$, and $B_{60}R_{120}$. The substitution of G with R radiation had little or no effect on leaf number and leaf size of either crop, or fresh and dry weight of tomato. However, as more G radiation was substituted with R radiation in the presence of FR, fresh and dry weight of lettuce increased by up to 34% and 29%, respectively. Regardless of the portion of G and R radiation, the addition of FR promoted plant growth of lettuce and tomato. In lettuce, the addition of FR increased plant diameter by 18-30%, fresh weight by 29-74%, and dry weight by 26-92%. In tomato, FR radiation increased plant height by 151-249% and fresh weight by 56-130%. These results show value in including of FR in an indoor radiation spectrum, while from a growth standpoint, there is little to no value of including green radiation.

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3:00 PM – 3:15 PM

A Greenhouse Lighting Control System That Delivers a Consistent Daily Light Integral (DLI) and Reduces LED Fixture Energy Consumption

Eli Mahanes Weissman[1]; Brian Poel[1]; Xiuming Hao[2] and Melanie Yelton[*1], (1)LumiGrow Inc., (2)Agriculture and Agri-Food Canada

Growers have typically relied on two strategies to illuminate their greenhouses with high-pressure sodium (HPS): continuous irradiation over a desired photoperiod, or threshold control that switches lights on and off at a defined solar intensity. Under these scenarios, fixtures usually deliver light at a constant photosynthetic photon flux density (PPFD) and the resulting daily light integral (DLI) may vary considerably. The superior dimmability of LEDs allows for variable supplemental PPFD throughout the day. We utilized a software system and algorithm to integrate information from solar light sensors and provide crops with a consistent DLI. The algorithm achieves a minimum preset DLI by averaging solar light values from three consecutive days and adjusting fixture intensity. Past research reports that a similar algorithm could maintain a DLI within 10 percent of a target on 87.5 percent of days (Albright, 2000). Data from five greenhouses (winter 2018-2019) demonstrated that achieving a target DLI depended on: the number of light sensors per unit area of growing space, amount of supplemental light available, maximum and minimum PPFD, and photoperiod length. Under ideal conditions, LED fixtures supplemented solar light to within 2 percent of the target DLI on greater than 90 percent of days. Compared to a 100-Watt outdoor pyranometer threshold, the DLI control system lowered energy consumption by as much as 65 percent. In conclusion, sensor-actuated LEDs provide value that goes beyond the estimated 10 to 27 percent efficacy savings associated with using LED rather than HPS fixtures.

3:15 PM – 3:30 PM

Characterization of Solar Radiation Spectral Contribution in Lettuce Bolting and Flowering Using LEDs in an Indoor Setting

Ricardo Hernandez[*], NC State University and Hans Spalholz, North Carolina State University

Lettuce bolting, induced by heat stress, plant age, and photoperiod is a detrimental trait as it reduces crop marketability and limits production season in the field. However, the impact of light quality on bolting is not fully understood. On a previous study, we found a light quality treatment with similar blue (B), green (G), red, and far-red (Fr) spectral ratios than solar spectrum (28B:35G:37R with 1.2R/Fr) that triggered flowering (stem elongation and rosette formation) on lettuce grown indoors. The objective of this experiment is to characterize how the different sunlight spectral components B, G, R, and Fr contribute to bolting initiation. To examine the role of each color on bolting, four light treatments were used, described as percent photosynthetic photon flux (PPF) and R/Fr ratio (B:G:R-R/Fr): (1) 28B:35G:37R-1.2R/Fr, (2) 28B:35G:37R-126R/Fr, (3) 43B:0G:57R-1R/Fr, and (4) 43B:0G:57R-15R/Fr. From day 3-11 plants were provided with 75 $\mu mol \cdot m^{-2} \cdot s^{-1}$ PPF for 18 h and increased to 150 $\mu mol \cdot m^{-2} \cdot s^{-1}$ PPF for 18 h from day 12 to 68. Morphological data was collected on day 18, 25, 32, 39, and 68. On harvest day 68, differences in stem length, which measures initial bolting response, were found. Plants grown in 28B:35G:37R-1.2R/Fr had 30% longer stems than in 43B:0G:57R-1R/Fr. Plants in 28B:35G:37R-126R/Fr and 43B:0G:57R-15R/Fr had 4.8- and 5.3-times shorter stem length than in 28B:35G:37R-1.2R/Fr, respectively. Additionally, plants in 28B:35G:37R-1.2R/Fr and 43B:0G:57R-1R/Fr had 3.9-5.0 times greater stem fresh mass than in 43B:0G:57R-15R/Fr and 28B:35G:37R-126R/Fr. No differences were found in total fresh or dry mass but plants in 43B:0G:57R-15R/Fr and in 43B:0G:57R-1R/Fr had 36% and 31% greater leaf fresh mass than in 28B:35G:37R-1.2R/Fr. Leaf area in 43B:0G:57R-1R/Fr and in 28B:35G:37R-1.2R/Fr was 11% and 8% greater than 28B:35G:37R-126R/Fr, respectively. These results demonstrate how individual colors can both regulate and accelerate the physiological transition towards the lettuce reproductive stage.

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3:30 PM – 3:45 PM

Alternating Red and Blue LED Lighting Eliminates Photo-Injury from Continuous (24 h) Lighting in Greenhouse Tomato Production

Jason Lanoue[1]; Xiuming Hao[*1]; Jingming Zheng[1]; Celeste Little[1]; Alyssa Thibodeau[1]; Brian Poel[2]; Melanie Yelton[2] and Shalin Khosla[3], (1)Agriculture and Agri-Food Canada, (2) LumiGrow Inc., (3)Ontario Ministry of Agriculture Food and Rural Affairs

Supplemental lighting is essential for year-round greenhouse crop production in regions with low natural light conditions. Long photoperiods of supplemental lighting such as continuous (24h) lighting (CL) could significantly improve crop growth and yield at the same light fixture costs. Furthermore, CL can increase overall energy efficiency because the heat released by the light fixtures reduces the heating requirement during the otherwise dark night period. However, lighting longer than 17 or 18 hours causes photo-injury such as leaf chlorosis in greenhouse tomatoes, cucumbers and sweet peppers, and limits the yield increase with CL. Our previous study found that light spectrum can affect the response of plants to long photoperiods of lighting. Therefore, we investigated the response of greenhouse tomato to CL with alternating red and blue LED light in this study. The study was conducted in 2 greenhouses, each with 50 m^2 of growing area during winter 2018-19. Each greenhouse was divided into 2 sections using white curtains which were impenetrable to light. Two lighting strategies (12 h lighting of red and blue together followed by 12 h darkness (control), and 12 h of red followed by 12 h of blue lighting (CL with alternating red and blue LED)) were applied to the 2 sections. The two lighting strategies had the same daily light integral. Plants grown under CL with alternating red and blue LED lighting were taller and had larger leaf area than the plants grown with 12 h of lighting (red and blue together, control) after 3 weeks of lighting treatments. The difference became insignificant after 50 days of lighting. There was no leaf chlorosis on plants grown under CL with alternating red and blue LED light and no difference on leaf chlorophyll, chlorophyll fluorescence and quantum yield with the 12 h (control) lighting treatment. Therefore, the CL lighting strategy with alternating red and blue LED light eliminated the photo-injury with CL.

Ornamentals/Landscape and Turf

Moderator: Ellen Bauske
University of Georgia, Griffin, GA, USA

2:00 PM – 2:15 PM

Research Priorities As Indicated By Industry Needs for Environmental Horticulture

Jill Calabro[*], AmericanHort/HRI; Jim S. Owen, Virginia Tech; Anthony LeBude, N.C. State University; Jennifer Boldt, USDA-ARS; James Altland, USDA-ARS, MWA ATRU and Jennifer Gray, AmericanHort

Environmental horticultural production, encompassing nursery and greenhouse, is present in all 50 states. It represents about one-third of the farm gate value of all specialty crops, and about 15% of the total value of U.S. crop production (USDA NASS Hort Crop Census 2014). Production value of nursery and greenhouse crops was estimated at $16.7 billion in 2013 (USDA NASS Hort Crop Census 2014). This places environmental horticultural production ahead of other major crop sectors such as wheat or cotton. To date, stakeholders in environmental horticulture production lacked a unified vision and blueprint that could be used to leverage needed resources to direct future research, education, extension and outreach (Bewick, pers. comm.). In an effort to meet this need, the Horticultural Research Institute (HRI) hosted the HRI Research Roundtable in December 2018, which combined 40 key greenhouse and nursery stakeholders with professional facilitation to identify current and future industry challenges and opportunities to increase future success and profitability. Through consensus, the group articulated the horticultural industry's research priorities and an executive summary was prepared. Four research priorities were identified and included (not listed in rank order or importance): (1) Quantitate and validate the ecosystem services and benefits of plants on human health and wellness. (2) Innovate biological, mechanical, and technological systems that provide efficient, productive, and profitable solutions relevant to producer size and segment. (3) Evaluate consumer-driven preferences that optimize industry-wide profitability and growth. (4) Solve ongoing and emerging industry challenges. These priorities will define internal activities within HRI, and are available also to federal agencies and state commodity groups to influence research funding.

Specified Source(s) of Funding: Horticultural Research Institute

2:15 PM – 2:30 PM

Seed Dormancy and Germination Responses to Temperatures in Seeds of Eight *Veronica* Species Native to Korea

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Korea National Arboretum has been conducting the project 'Wild Flowers' for the commercialization of wild flowers native to Korea. In this project, we have selected Korean native *Veronica* species as new ornamental potted or landscape plants. Firstly, we investigated the seed germination characteristics of eight Korean native *Veronica* species (*V. dahurica, V. rotunda, V. kiusiana* var. *diamantiaca*, *V. pusanensis*, *V. rotunda* var. *subintegra*, *V. nakaiana*, *V. pyrethrina*, and *V. kiusiana* var. *glabrifolia*), and seed dormancy types (kinds) of the seeds were classified. Among the study species, *V. kiusiana* var. *diamantiaca* has been designated as both an endemic and rare species (critically endangered) and *V. pusanensis* is endemic species in Korea. The seeds were incubated at constant temperatures of 4, 15, 20, 25, and 30°C for 30 days, and germination percentages were calculated. Embryo morphology was observed in initial seed and at just before germination. The optimum germination temperatures of the seeds of the eight *Veronica* species were approximately 20 to 25°C. Although the seeds of *V. rotunda* and *V. kiusiana* var. *diamantiaca* germinated to 66.1% and 47.6%, respectively, the seeds of the other *Veronica* species germinated to more than 90% at five temperature regimes for 30 days, The embryo length inside the seeds increased by 18.8 to 58.0% of their initial length. To promote the germination of *V. kiusiana* var. *diamantiaca* seeds, we treated the seeds with different periods of cold stratification (0, 3, and 6 weeks at 4°C) and gibberellic acid (GA_3) soaking (0, 50, 100, and 1,000 $mg \cdot L^{-1}$). The seeds of *V. kiusiana* var. *diamantiaca* germinated to 45.0, 75.3, and 80.3%, respectively, following 0, 3, and 6 weeks of cold stratification. The seeds of of *V. kiusiana* var. *diamantiaca* germinated to 44.7, 71.3, 87.2, and 91.7%, respectively, following the soaking treatment of different concentrations of GA_3 (0 [control], 50, 100, and 1,000 $mg \cdot L^{-1}$). There were different types of seed dormancy (MD and MPD) within the eight *Veronica* species examined; thus, we found an interspecific variation in seed germination traits in the genus. The results could be useful to study the morphological seed dormancy and ecophysiological mechanisms of the genus *Veronica*.

Specified Source(s) of Funding: KNA1-2-33,17-8 project funded by Korea National Arboretum

2:30 PM – 2:45 PM

Effects of Chilling and GA_3 on Bud Differentiation and Development of Herbaceous Peonies

Dongfang Zhou*[1]; Daniel L. Jackson[2]; Holly L Scoggins[1]; W. Garrett Owen[3]; Sherif Sherif[1] and Joyce Griffin Latimer[4], (1)Virginia Tech, (2)The University of Georgia, (3)Michigan State University, (4)Virginia Cooperative Extension
Herbaceous peonies (*Paeonia lactiflora* Pall.) are common perennials used both in gardens and landscape as well as cut flowers. Peonies require a chilling period for dormancy release and flowering. Gibberellic acid (GA_3) can partially replace the chilling requirement. The objective of this study was to evaluate GA_3 effects on peony bud differentiation and development during controlled chilling and early forcing, as well as growth and flowering. Two peony cultivars, 'Sarah Bernhardt' and 'Inspecteur Lavergne', 3-5 eyed crowns from Holland were potted in 3.8-L pots in mid November, allowed to root for 5 weeks, then placed in a 5°C cooler for 4 weeks. GA_3 (Florgib, Fine Americas) was applied as a 100 mg/L drench (250 ml/pot) just before or immediately after chilling. Bud differentiation and development was monitored using stereomicroscope at potting, after rooting (before chilling), after 1, 2, 3 or 4 weeks of chilling, and at 5, 10 or 15 days after chilling. All buds were removed from the sample plants, measured, and dissected under a stereomicroscope to assess development. Root dry weights and crown dry weights were also determined after rooting, after chilling, and 15 days after chilling. Ten plants of each treatment were grown in the VT greenhouse F4 after chilling until flowering. Data indicate that plants treated with GA_3 prior to chilling had a greater number of buds that were also larger and in higher differentiation stages than did untreated plants. For plants grown in greenhouse, GA_3 treatments prior to chilling shortened the days to emergence by 7 days and shortened the days to cracking color by 15 days with 'Sarah Bernhardt'. GA_3 treatments (both before and after chilling) shortened the days to emergence and cracking color by 14 to 15 days with 'Inspecteur Lavergne'. GA_3 treatment prior to chilling increased the number of shoots with both cultivars and GA_3 applied after chilling increased the number of flowers with 'Inspecteur Lavergne'.

Specified Source(s) of Funding: Fine Americas

2:45 PM – 3:00 PM

Evaluation of Pollinators and Beneficial Arthropods on Ornamental Perennials in North Dakota

Veronica Calles-Torrez*; Esther E. McGinnis; Harlene Hatterman-Valenti; Patrick Beauzay and Janet Knodel, North Dakota State University
Many species of pollinators, especially honeybees and wild bees, are experiencing decline due to forage and habitat losses. Planting flowering perennial species is one of the recommendations to reduce bee decline. The goal of our study was to evaluate four commonly available genera of perennials for their ability to attract pollinators and beneficial arthropods in an urban landscape (Fargo) and a rural landscape (Absaraka) in North Dakota. The four genera were bee balm (*Monarda* L. spp.), stonecrop (*Hylotelephium* H. Ohba spp.), false indigo (*Baptisia* Vent. spp.), and aster (*Symphyotrichum* Nees spp.). A mix of six to eight species and/or cultivars were planted per genus in 2018 with six replications per location. Each plant was observed weekly during flowering for three minutes and the number of visits from pollinators and beneficial arthropods were counted.

Examples of pollinators included honeybees, bumblebees, black bees, metallic bees, butterflies, moths, and syrphid flies. Beneficial arthropods were parasitic wasps, yellow jackets, ants, minute pirate bugs, lady beetles, green lacewings, spiders, and daddy long-legs. A total of 756 arthropod specimens were observed at the Fargo site, and 2,731 specimens at Absaraka. In Fargo, 93.1% of specimens were pollinators and 6.4% were beneficial arthropods. Observations at Absaraka indicated 74.4% of the specimens were pollinators and 25.6% were beneficial arthropods. The genera *Hylotelephium* and *Symphyotrichum* attracted more pollinator visits at both locations. In Absaraka, *Symphyotrichum* and *Hylotelephium* spp. attracted the majority of beneficial arthropod visits. Very few beneficial arthropods were observed at the Fargo site. No data were available from *Baptisia* plants because they flowered prior to transplanting. The landscape effect is one of the potential reasons for higher arthropod specimen numbers at the Absaraka site compared to Fargo. Absaraka is located in a rural, wooded area. In contrast, the Fargo plots are located in an urban area with regular mosquito spraying during the summer months. Overall, *Hylotelephium*, *Symphyotrichum*, and *Monarda* spp. show promise to attract pollinators and beneficial arthropods.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant

3:00 PM – 3:15 PM

Economic Benefits of PGRs in Landscape Maintenance

Enrique Velasco and Ariana Torres*, Purdue University

The landscape maintenance industry generates important economic contributions in the United States; over 1 million jobs and $54.7 billion in total sales in 2013 (Hodges et al., 2015). According to Lawn & Landscape (2015) State of the Industry Report, landscape maintenance is the category predicted to grow the fastest in this industry. Among all landscape plants, shrubs are an essential part of the landscapes. Shrubs provide color, forms, textures, shades, coverage, and noise-cancelling features to the place they are set (Rainbow, 2016). Shrubs draw attention at first sight, and this impact can be negative if shrubs are not correctly treated and maintained. In other words, shrub maintenance is a major way for landscape maintenance companies to convey the quality of their services.

Labor is the single largest expense in agriculture, and the landscape maintenance industry is not an exception. Labor costs can represent between 30% to 55% of all costs for landscape business (IBIS World, 2018). Thus, labor savings is one of the most important tasks for business owners and managers in the industry. In looking for cost-effective ways to lower labor costs, landscape maintenance businesses have started using Plant Growth Regulators (PGRs), being Paclobutrazol one of the most tested products. PGRs are regularly applied in commercial ornamental plant production to control growth (Gent and McAvoy, 2000). PGRs suppress shoot growth by blocking the production of phytohormones associated with plant cell elongation (Hedden and Graebe, 1985).

Some of the industry claims on the benefits of PGRs for shrub maintenance are reducing shorter pruning time, delaying spring and early summer pruning, increasing labor safety, improved plant appearance, and freeing labor time for other jobs. Our study investigates the economic benefits of PGRs on the labor savings of landscape maintenance companies. Specifically, we investigate the labor savings (in dollars) determined by shortening pruning time and waste disposal reductions. We also draw conclusions on potential labor reallocation savings and labor safety.

Our data comes from experiments conducted in Buena Vista & Western Bay (Florida), Cinco Ranch (Texas), Raceway area by golf course (Indiana) and Leesburg, Ocala (Florida). We used number of prunes per year and hours of pruning to measure the reduction of growth in 5 shrub species: *Confederate jasmine, Asiatic jasmine, Thorny eleagnus, Viburnum odoratissimum and Ligustrum japonicum*.

We used a partial budget analysis to evaluate the financial effect of incremental changes in labor savings due to an adoption of PGRs for shrub maintenance. The partial budget analysis uses only the additional inputs and outputs generated due to the use of PGRs in shrubs, rather than an entire company budget. Similar studies have used partial budget analysis to understand the money saving effect of technologies in agriculture (Barret et al., 2012).

We will also perform a sensitivity analysis on two different variables: the variations in growth reduction due to PGR rates and labor wages. The sensitivity analysis can allow us to understand how savings respond to changes on shrub growth reduction and labor wages (Boardman et al., 2001). Finally, we will survey landscape businesses to understand their labor reallocation preferences due to shorter pruning time, delayed pruning time peaks, and occupational safety.

PGR treatments were issued in periods of 6-week and 12-weeks, with application rates of 9.6 fl. oz./gal and 6.4 fl. oz./gal. Shrubs received, on average, 2 applications of PGR per year, with a reapplication interval of 12 weeks after the initial treatment. Pruning of untreated shrubs occurred 8 to 30 times/year, while treated shrubs were pruned 2 to 7 times/year, depending on the specie. PGR application took 2.86 minutes/gallon covering 461 square-feet, on average. Additional variables analyzed were pruning time, waste biomass reduction (averaged between 34% and 36% based on *Ligustrum japonicum*).

Some results show that applying PGRs can, on average, reduce the number of prunes by 64.5% and the time of pruning by 56%. Together, these results show landscape maintenance businesses can reduce 443 hours of labor per year due to labor savings in pruning, depending on shrub specie. Considering a minimum wage of $7.25/hour, this translates into savings of around $3,217 per year. In addition to the data obtained from the study, our study will draw conclusions on improved occupational safety, labor reallocation savings, and labor productivity due to shorter maintenance time.

3:15 PM – 3:30 PM

The Importance of Irrigation Scheduling for Water Savings with Turfgrass Grown in Soils Amended with Biochar

Jonathan F. Montgomery*, University of California, Riverside

Traditionally, the availability of soil water has been determined using pressure plates and similar methods; though some literature suggests that their suitability is highly dependent on soil characteristics which biochar products can modify. Prior research suggests that biochar and compost can increase the water holding capacity of soils and ameliorate water regimes under drought conditions. However, this may not translate to improved availability of this water as permanent wilting point can be reached at higher water contents. For this work we used Tall Fescue (*Festuca arundinacea*) performance to indicate when irrigation was necessary and correlated soil water potential as well as gravimetric water content to evaluate the suitability of these methods as predictors of plant drought stress in biochar and compost-amended soils. The primary objective of this study was to measure the impacts of biochar and compost on soil-water dynamics while including measurements of plant performance to more accurately predict how these products can be used in the field. Irrigation frequency and quantity was determined based on plant health, allowing a determination of irrigation required by the plant rather than focusing on performance under predetermined irrigation regimes. Turfgrass was found to survive with reduced available water in amended soils, requiring less irrigation to maintain acceptable quality. Future investigations using these products should include incorporation of amendments into field soil, planting of the desired turf, and initiation of drought stress to predict true plant response.

3:30 PM – 3:45 PM

Impact of Paclobutrazol Application on Physiology of Urban Street Trees

Bert Cregg* and Dana Ellison, Michigan State University

Paclobutrazol is a tree growth regulator that is widely used by arborists, particularly to control height growth of trees near utilities. Paclobutrazol is also increasingly marketed as stress mitigation treatment in urban trees due its fungistatic properties effects and effects on plant drought tolerance. In this study we applied paclobutrazol (tradename Cambistat) as a soil drench to Callery pear (*Pyrus calleryana*) trees planted as street trees at two sites in downtown Lansing, MI. We assessed shoot and leaf growth and physiological responses for two years following application. Paclobutrazol reduced leaf size and increased SPAD chlorophyll content in both years. Net photosynthetic rate increased in the first year following application but was unaffected two years after application. The results suggest that paclobutrazol application my help to offset urban stresses by reducing leaf size resulting in increased nutrient content (as indicated by SPAD index) and increased photosynthetic efficiency.

3:45 PM – 4:00 PM

Hurricane Disaster Relief Training for Chainsaw Users: Empowering Responders and Creating Resilience

Ellen Bauske*, University of Georgia; Lucy K. Bradley, North Carolina State University and Cory Tanner, Clemson University

During the 2018 hurricane season two powerful storms ravaged parts of Florida, Georgia, North Carolina, and South Carolina: Florence in September and Michael in October. These storms destroyed trees throughout the Southeast. The residents, professional tree care companies, and public entities responded by reaching for their chainsaws and getting to work. Given the dangers of arborist work, the inexperience of many chainsaw users, and the unique dangers inherent in storm-damaged tree removal, the need for safety training was urgent. A storm-damaged tree cleanup safety training was created and implemented as quickly as possible with support from the OSHA Susan Harwood Training Grant Program. The goal was to create a one-hour training that could be rapidly delivered by county agents. Powerpoint presentations and scripts were created covering personal protective equipment, stinging/biting insects, safe saw carry, site inspection, and safe saw start. Program evaluations were developed, and publications prepared. The training received one International Society of Arboriculture continuing education credit. All materials were located on a website for easy access (https://ugaurbanag.com/disaster/). In a train-the-trainer format, county extension agents in South Carolina and North Carolina were provided with instruction, demonstration equipment, publications, PowerPoints, and program evaluations with the expectation that they would then provide training to first responders in their counties. Five agents from Georgia with previous experience in saw safety trained 15 agents in South Carolina and 14 in North Carolina by mid-December. Each agent received a training kit consisting of hard hats, chaps/saw pants, safety glasses, ear plugs/muffs, and ANSI Standard Z133 Safety Requirements for Arboricultural Operations. As of mid-February, agents had trained over 350 people. The average class size was small (14.5 people). Evaluations were positive. Ninety percent of the participants said they learned something they did not know previously and everyone who responded to the question said they would recommend the training to others. The training has helped strengthen ties between city and county departments and Cooperative Extension. The impact of this project will continue as agents now have the resources to address emergency response issues in the future.

Specified Source(s) of Funding: Grant number SHO5O77SH8 from the Occupational Safety and Health Administration, U.S. Department of Labor

Viticulture and Small Fruits 1

Moderator: Jeremiah Q. Loyd
Fresno State, Fresno, CA, USA

2:00 PM – 2:15 PM

Machine Harvesting Blueberries in the Pacific Northwest

Fumiomi Takeda*, Appalachian Fruit Research Station; Wei Qiang Yang, North Willamette Res & Ext Center; Mengyuan Zhang, N/A; Lisa Wasko DeVetter, Washington State University Northwestern Washington Research and Extension Center; Randolph Beaudry, Michigan State Univ; Patrick Abeli, Michigan State University and Scott Korthuis, Oxbo International

As harvesting labor costs steadily rise, blueberry growers are increasingly using over-the-row (OTR) machines designed to pick berries for the processed market to harvest their crop for the fresh market. Postharvest evaluations have shown that harvesting blueberries with conventional OTR machines results in fruit with a shorter shelf-life, excessive internal damage and lower fruit firmness (g/mm) than hand-harvested blueberries. Much of the loss in fruit quality from OTR machines is from impact damage or fruit falling directly on the harvester's hard surfaces, such as the plastic catch plates and conveyor belts. In 2018, OTR blueberry harvesters (Oxbo 7440 and 8040) with the Orbirotor® picking heads and modified fruit catching surfaces were used to harvest northern highbush blueberries in Oregon and Washington. The modifications included softer berry catch plates and soft intermediate fruit collecting surfaces over the conveyor belts. These changes to the catching surface alone resulted in fruit quality of machine-harvested 'Duke' and 'Draper to be nearly like that of hand-harvested fruit in terms of firmness and bruising. Reducing the drop height in OTR machines with intermediate soft fruit catching surfaces and soft catch plates instead of letting detached blueberries drop directly onto hard plastic catch plates and conveyor belts improved fruit quality and pack-out percentage. The details of harvester modifications and trials and tribulations of field testing of blueberry harvesting systems will be discussed.

Specified Source(s) of Funding: Award No. USDA-NIFA-SCRI-004530

2:15 PM – 2:30 PM

Modified over-the-Row Machine Harvesters Increase Pack-out and Fruit Quality Compared to Standard Machine Harvesters

Lisa Wasko DeVetter*, Washington State University Northwestern Washington Research and Extension Center; Fumiomi Takeda, Appalachian Fruit Research Station; Wei Qiang Yang, North Willamette Res & Ext Center and Scott Korthuis, Oxbo International

Increasing labor costs and low worker availability challenge farms that grow highbush blueberry for the fresh market. Mechanizing harvest operations while maintaining fruit quality and harvest efficiency would greatly benefit the fresh market blueberry industry by reducing growers' reliance on hand labor for harvesting. Over-the-row (OTR) harvesters are routinely used to harvest fruit for the processing market. However, current commercial OTR harvesters are not routinely used to harvest fresh market blueberry due to increased internal bruise damage of harvested fruit. In this study, a modified Oxbo 8040 OTR harvester with soft-catching surfaces designed to reduce bruising was studied in Oregon and Washington in 2018. Early-to-late season 'Duke', 'Draper', and 'Liberty' were harvested with the modified Oxbo 8040 and compared to standard OTR harvesters and hand harvest. Pack out, fruit firmness, internal bruise damage, and postharvest quality were evaluated. The modified Oxbo 8040 had fruit quality and pack out equal or comparable to hand harvested fruit and better than standard OTR harvested fruit. Higher fruit quality was generally maintained for 2-3 weeks with hand harvested fruit but not for machine harvested fruit. Pack out also varied by cultivar, with pack out being greater for 'Duke' and 'Draper' compared to 'Liberty'. Ground speed and head speed of the harvester also impacted pack out and was cultivar dependent. Overall, harvest efficiency is improved using OTR harvesters and the soft-catching surfaces in the modified Oxbo 8040 reduced bruising and improved fruit quality compared to standard OTR harvesters. Pack out and fruit quality were cultivar and plant size dependent, indicating optimizing machine harvesting parameters for fresh market fruit will have to include these factors by the harvester operator.

Specified Source(s) of Funding: Washington Blueberry Commission

2:30 PM – 2:45 PM

Postharvest Quality of Blueberries Harvested By a Modified over the Row Mechanical Harvester

Wei Qiang Yang*, North Willamette Res & Ext Center; Fumiomi Takeda, Appalachian Fruit Research Station; Lisa Wasko DeVetter, Washington State University Northwestern Washington Research and Extension Center; Randolph Beaudry, Michigan State Univ; Mengyun Zhang, University of Goergia; Patrick Abeli, Michigan State University; Scott Korthuis, Oxbo International and Changying Li, University of Georgia

Modified over the row (OTR) mechanical harvesters (Oxbo 7440 and 8040) were used to harvest early to late season blueberries ('Duke', 'Draper', and 'Aurora') for the fresh market in the Pacific Northwest in 2017 and 2018. Fruit were sorted on packing lines and stored up to four weeks in commercial coolers. Fruit firmness, internal bruising

damage (IBD), Brix, and acidity of machine-harvested fruit were compared to handpicked fruit. No difference in fruit acidity was observed between machine and hand harvested fruit after packing. Although the firmness of machine-harvested fruit was generally acceptable for fresh market, fruit firmness decreased more in cold storage than handpicked fruits. The correlations between fruit firmness and IBD of various cultivars after packing and during storage failed to show consistency. Such inconsistencies in packed fruit appeared to be caused by the location of IBD, while firmness measurements by FirmTech were always taken at the fruit equator. Near-infrared hyperspectral imaging (HSI) can locate IBD. FirmTech measurements at 0, 90^0 and 180^0 from the IBD location produced different firmness readings on the same berry depending on the size of IBD. HSI also found many fruits with moderate to extensive IBD in fresh packed clamshells. The data suggest that HSI has great potential to better sort blueberries for fresh market by eliminating fruits with moderate to severe IBD.

Specified Source(s) of Funding: Oregon Blueberry Commission

2:45 PM – 3:00 PM

Evaluation of Physical and Chemical Fruit Characteristics As Early Predictors of Shelf Life in Three Commercial Blueberry Types Held in Postharvest Cold Storage

Rion Mooneyham* and Rachel A. Itle, University of Georgia

Three main commercial types are grown for the United States blueberry market. These are northern highbush (NHB, *Vaccinium corymbosum* L.), rabbiteye (RE, *V. virgatum* Aiton), and southern highbush (SHB, *Vaccinium* sp., which is a species complex between *V. corymbosum* L. and *V. darowwi* Camp). NHB blueberry types are grown in northern states of the country. The majority of blueberries grown in Georgia are RE and SHB types. SHB and NHB blueberries are perceived to have superior fruit quality characteristics compared to RE, yet information to support this is limited. Storage capability, rate of spoilage, and fresh postharvest keeping quality of these types is largely unknown. The main objective of this study was to investigate if percent healthy fruit of respective cultivars can be predicted based on 2017 and 2018 blueberry harvest seasons' physical and chemical fruit quality attributes of SHB, RE, and NHB blueberries. Fruit were collected from commercial packers representing the early-, mid-, and late- 2018 harvest season from Michigan, Canada, and Georgia. Cultivars included were: seven SHB [‘Star’, ‘Farthing’, ‘Meadowlark’, ‘Legacy’(from GA and MI), ‘Camellia’, ‘Keecrisp’, and ‘Suziblue’], five RE (‘Vernon’, ‘Alapaha’, ‘Brightwell’, ‘Powderblue’, and ‘Austin’), and five NHB (‘Bluecrop’, ‘Draper’, ‘Nelson’, ‘Elliott’, and ‘Liberty’). All except ‘Powderblue’, ‘Austin’, and ‘Brightwell’, were hand-harvested. Fruit were kept at 4 °C after collection and processed for a 30 day period at four timepoints (TP): 1) 3-4 days, 2) 10-11 days, 3) 20-21 days, and 4) 30-31 days. Physical characteristics evaluated included: skin strength (puncture-in), and fruit firmness (Kramer shear). Chemical characteristics evaluated include: soluble solids, total titratable acidity, and sugar/acid ratio. Low and high ethylene emitting cultivars were also evaluated to see their relationship with percent healthy fruit. Pearson's correlation coefficients were performed between physical and chemical fruit attributes during TP1 and % healthy fruit of TP3. Analyses will determine significant differences in % healthy fruit and significant correlations that will enable early detection of postharvest losses that certain cultivars may experience more than others. Indicators of percent healthy fruit would be beneficial to producers to target specific markets based on postharvest storage capabilities of cultivars and choose those cultivars best suited for long term postharvest storage. This information will be used to help growers and breeders select and develop new cultivars with superior postharvest keeping quality.

3:00 PM – 3:15 PM

Hygiene Conditions of Fresh Blueberry Packing Lines and Microbial Quality of Fresh Market Blueberries in Georgia

Jinru Chen, University of Georgia; Fumiomi Takeda, Appalachian Fruit Research Station and Lisa Wasko DeVetter*, Washington State University Northwestern Washington Research and Extension Center

Foodborne outbreaks have been linked to the consumption of blueberries contaminated with pathogenic bacteria. The microbial quality of blueberries could be influenced by the hygenic conditions prevailing during postharvest handling. This study evaluated the hygienic conditions of six fresh blueberry packing lines and microbial quality of fresh market blueberries in Georgia. Five of the six packing lines were sampled twice and the remaining one was sampled once during the summer of 2015 and the summer of 2017. A delimited area on each of the ten selected sites of the packing lines was swabbed with sterile sponges before the packing started (AM samples), during lunchtime (NOON samples), and at the end of the packing day (PM samples). The sponges were thoroughly rinsed with Dey-Engley neutralization broth and sampled for total aerobes, yeasts and molds, total coliforms, fecal coliforms, and enterococci. Meanwhile, unpacked and packed blueberries (n=124) were collected in duplicate for assessment of microbial contamination. Resulting microbial colonies were enumerated and presumptive fecal coliforms and enterococci confirmed. Results of the packing line survey showed that sample site and sampling time had a significant influence ($P \leq 0.05$) on total aerobic, yeast and mold, and total coliform counts. The PM samples had significantly higher ($P \leq 0.05$) total aerobic and yeast and mold counts than the NOON samples which had significantly higher ($P \leq 0.05$) counts than the AM samples. Fourty-six out of the 310 (14.8%) collected samples tested positive for enterococci while 27 (8.7%) samples tested positive for fecal coliforms. Berry lugs, rubber belts on color sorters, and premature berry disposing areas had significantly higher (*P*≤0.05) microbial counts than the other sites. For the berry analysis, eleven berry samples from three packing houses tested positive for fecal coliforms and one sample tested positive for enterococci. Mean total aerobic counts, total yeast and mold counts, and total coliform counts of the berries were 3.89, 4.42 and 1.42 log CFU/g, respectively. Sampling time had significant influence (*P*≤0.05) on the recovery of all three groups of microorganisms. On average, berry samples collected at the end of the day had the lowest microbial counts. In general, the packing process had no significant influence (*P*>0.05) on recovered microbial counts, however, unpacked berries had numerically higher aerobic counts and yeast and mold counts than packed berries. This study suggests that sorting of blueberries before packing for the fresh market does not lead to significant reductions in microbial counts.

Specified Source(s) of Funding: USDA NIFA 2014-51181-22383

3:15 PM – 3:30 PM

Comparing Consumer Overall Liking and Fruit Quality Traits of Southern Highbush and Rabbiteye Blueberry Cultivars

Kathleen Amaral* and Rachel A. Itle, University of Georgia

The blueberry commercial production is essential for the state of Georgia. Georgia's industry consists of two of the main commercially grown blueberry types in the United States: southern highbush (SHB, *Vaccinium corymbosum* L. and *V. darrowii* Camp) and rabbiteye (RE, *V. virgatum* Aiton). There are various subjective opinions, within the industry, that SHB fruit quality is superior compared to that of RE, however few instrumental and consumer sensory tests have been conducted. The objectives of this study were to determine the consumer overall liking preference of the same SHB and RE cultivars that were collected during the 2016 and 2018 harvest season and determine whether cultivar overall liking was due to texture, skin toughness, firmness, seediness, flavor and aroma. Four SHB and two RE cultivars were collected from commercial packers in Alma, GA for both harvest seasons. SHB cultivars included 'Camellia', 'Farthing', 'Star', Legacy'; and RE cultivars included 'Vernon' and 'Alapaha'. Samples were served to consumers at room temperature using a three-digit binding code for each cultivar and a Latin Square design. Consumer acceptability was scored using a 9-point hedonic scale (1= extremely dislike and 9= extremely like) for 'liking/acceptability' of aroma, flavor, texture, skin toughness, seediness and overall liking. Three SHB cultivars, 'Legacy', 'Camellia' and 'Farthing', were highly accepted for their flavor (6.47-7.47), aroma (6.39-6.72), texture (6.89-7.20), skin toughness (6.81-7.36), fruit firmness (7.05-7.55), and seediness (6.23-7) for both years. 2016 and 2018 'Alapaha' and 'Star' and 2018 'Vernon' were the least favored. SHB were preferred by consumers, for both years, due to their flavor, texture, crisp skin, and seediness. RE were preferred by consumers due to their aroma, however, disliked due to their mealy, seedy, and soft texture. These results suggest fruit quality characteristics may vary by harvest season, affecting consumer perception. This information may be useful to the blueberry industry to market specific cultivars within a type that maintain similar fruit quality characteristics throughout multiple harvest seasons.

3:30 PM – 3:45 PM

Rot Estimation Dynamics in Gondolas

Walsh A. Conmy*; Jeremiah Q. Loyd; Justin Davis; Sonet Van Zyl and Stephan Sommer, Fresno State

Daytime temperatures in the San Joaquin Valley can reach well over 37°C during harvest. Biological and chemical reaction processes are increased as the temperature increases. Thus wine grapes are commonly harvested in early morning hours to prevent heat from affecting chemical and biological reaction rates, i.e., spoilage of grapes by microorganisms. With growers and processing facilities being spread out over large distances, longer transport times or waiting in line to be processed at a winery's test stand, processing the grapes might take longer and the gondola will be subjected to warmer parts of the day. Three truck loads of gondolas from three different vineyards were sampled every two hours, from 6:00 a.m. to 2:00 p.m. for FT-MIR analysis and temperature tracking. Analytical attributes tracked over the course of this study included brix, titratable acidity, ethanol, volatile acidity, tartaric acid, malic acid, gluconic acid, glucose, and fructose. Volatile acidity and gluconic acid were more closely looked at as they are seen as rot indicators. Higher rates of gluconic acid can be formed through fungal metabolism, as it is a metabolite of *Penicillium*, allowing the first carbon of glucose to become oxidized. The goal was to test the FT-MIR based calibration model to determine beginning levels of microbial spoilage in gondolas and find if temperature has an effect on the growth of the microbial contaminants in gondolas. Results of the three truck loads of gondolas show a significant linear increase of temperature of juice, gluconic acid, volatile acid, and FT-MIR rot predicted values based on time.

Specified Source(s) of Funding: California Wine Grape Inspection Advisory Board

3:45 PM – 4:00 PM

Influence of Bunch Rot on Fermentation Kinetics in Chardonnay and Petite Sirah

Jeremiah Q. Loyd*; Justin Davis; Walsh A. Conmy; Sonet Van Zyl and Stephan Sommer, Fresno State

Higher levels of fungal infections on wine grapes can negatively impact fermentation behavior and the flavor profile of the finished wine. The most common molds that were shown to have an impact on grape quality are *Botrytis, Penicilium*, and *Aspergillus*. The objective of this study was to evaluate

An asterisk (*) in front of a name indicates the presenting author.

the effects of different levels of bunch rot on fermentation kinetics. Clean and infected grapes were crushed separately to prevent contamination. Four lots of Chardonnay were crushed into six separate twelve gallon fermentations and divided into two clean controls, 5%, 10%, 15%, and 20% rot by volume to volume. One lot of Petite Sirah was crushed and divided into two two clean controls, 10%, and 20% rot weight by weight. Samples were taken daily for FT-MIR analysis. Analytical attributes tracked over the course of fermentation were changes in brix, titratable acidity, ethanol, volatile acidity, tartaric acid, malic acid, gluconic acid, glucose, and fructose. The goal was to develop an FT-MIR based calibration model to determine the level or concentration of rot that affects the final wine in white and red varieties. The wines were also subjected to difference and preference testing by a trained sensory panel to determine differences between control wines and wines made from infected grapes. Sugar levels were higher in the initial juice containing 20% rot compared to the control, however all wines were fermented to dry. Infected grapes consistently recorded higher levels of titratable acidity, volatile acidity, fermentable sugars, and ethanol. Preliminary sensory studies based on preference showed minimal differences in 5%, 10% and 15%, furthermore 20% wines indicated distinct differences in sensory from controls. Vineyards suffer quality loss due to fungal contamination, currently visual inspections of fungal contamination is the standard practice to quantify rot quality. The analytical testing of the quantification of rot percentage levels, based on the FT-MIR rot indicator matrix, assists in creating a new industry standard for fungal identification pre and post harvest, and understand sensory differences in fungal infected wines.

Specified Source(s) of Funding: California Wine Grape Inspection Advisory Board

Genetics & Germplasm 2

Moderator: Brian Ward
Clemson University CREC, Charleston, SC, United States

3:30 PM – 3:45 PM

Leveraging a High-Throughput Phenotyping Method to Study Anthocyanin Genetics in Blueberry

Kelsey J. Zielinski[1]; David Honigs[2]; Mary Grace[1]; Molla F. Mengist[1]; Mary Ann Lila[3] and Massimo Iorizzo[*1], (1)North Carolina State University, (2)Perten Instruments, (3)Plants for Human Health Institute, North Carolina State University

Blueberry (*Vaccinium* sp.) is a well-recognized, health-protective fruit with functionality derived from micronutrient and phytochemical density, particularly anthocyanins. Despite their importance, little is known about the genetic underpinnings controlling anthocyanin accumulation in this crop. Further elucidation of these mechanisms could facilitate the development of new blueberry cultivars with improved nutritional qualities; therefore, the purpose of this research was to develop an *ad-hoc* phenotyping method suitable for screening the total anthocyanin content (TAC) in blueberry for genetic association studies. The most commonly used method for quantifying TAC involves extracting anthocyanins from whole blueberries, which may bias results given that anthocyanins are expressed mainly in the skin tissue. To assess this, 30 genetically diverse blueberry genotypes were selected and quantified for TAC using two methods: the commonly used whole-fruit method ("whole-method"), and one which uses only the skin tissue for extraction of anthocyanins ("skin-method"). In addition, fruit from each sample was photographed and then analyzed using an image processing software, GiNA, in order obtain total surface area (TSA) per sample. Fruit size using the whole-method provided a significantly higher correlation with the observed TAC ($r = 0.85$) when compared to that of the skin-method ($r = -0.43$), indicating a potential bias and lack of precision in using the whole-method for genetic studies. Finally, given that quantifying TAC using high-performance liquid chromatography (HPLC) is relatively expensive and time consuming, and that genetic studies often employ hundreds to thousands of samples for analysis, it is critical to develop a method that is high-throughput. To achieve this goal, a total of 57 genetically diverse blueberry genotypes were processed using the skin-method and scanned using a Perten DA 7250 near-infrared (NIR) analyzer. The resulting spectra were combined with corresponding reference analysis data (HPLC) to produce a calibration curve. A comparison of observed and predicted values in the calibration dataset revealed that the model accounted for 81% of observed variation in TAC (R-2 = 0.8073). This result demonstrated that NIR can be applied as a high-throughput method to measure TAC in blueberry.

3:45 PM – 4:00 PM

Comparison of Conventional and Organic Sweetpotato Cultivar Trials Utilizing Plasticulture and Bare Ground Cultural Practices

Brian Ward[*], Clemson University CREC; Livy Williams, USDA ARS US Vegetable Laboratory; Matthew Cutulle, Clemson University; Matthew Horry, Clemson and Phillip A. Wadl, USDA-ARS, U.S. Vegetable Laboratory

There is a resurgence of interest in sweetpotato production in South Carolina for processing and fresh market. Recently, there has been special interest in organically produced sweetpotato. This study, conducted in 2016 and 2017 in the coastal plain of South Carolina near Charleston was conducted to evaluate the performance of commercial cultivars and advanced breeding lines under different soil types, microenvironments and bare ground versus plasticulture growing conditions. In 2016 we evaluated 24 commercial and advanced breeding lines, and in 2017 14 lines were studied. Data collected were: total yield (bushels/acre), marketable yield (bushels/acre) percentage U.S. grade number

1 roots, percentage yield difference, percentage uninjured roots, wireworm, *Diabrotica*, and *Systena* (WDS) severity index, percentage flea beetle damage, percentage grub damage, percentage sweetpotato weevil damage, percentage root rot, percentage root cracking, percentage roots misshaped, and wireworm species diversity. Results were mixed over years and with regard to genotype, organic versus conventional cultural practice and bare ground versus plasticulture. Nevertheless, we identified several promising advanced breeding lines that performed well under all conditions.

Specified Source(s) of Funding: SCDA SCBGP

4:00 PM – 4:15 PM

Phenological Diversity of Wild and Hybrid Grapevines in the USDA-ARS *Vitis* Collection in Geneva, NY

Benjamin Gutierrez*; Heidi Schwaninger; Jie Arro; Chi-hcheng T. Chao and Gan-Yuan Zhong, USDA-ARS Plant Genetic Resources Unit

Grapes are one of the most economically important fruit crops worldwide and are increasingly grown in diverse environments. Grapevine phenology, the seasonal timing of budburst, flowering, and fruit ripening, is a major climate-dependent factor contributing to the local commercial adaptability of grape cultivars. To explore the phenological diversity of wild and cultivated genetic resources in the USDA-ARS *Vitis* collection in Geneva, NY, USA, date of budburst, bloom, and veraison were recorded for 1,573 accessions from 2011 to 2013. Additional historic phenological data was retrieved from the Germplasm Resources Information Network (GRIN-Global). Growing degree days (GDD) from base 10 °C were calculated from day 60. Budburst values ranged from 15.1 to 128.6 with an average of 62.9 GDD, bloom date ranged from 171.3 to 1029.6 with an average of 337.1 GDD, and veraison ranged from 823.5 to 1571.8 with an average of 1172.9 GDD. Seasonal correlations were high for bloom and veraison (0.86 to 0.95) and moderate for budburst (0.60 to 0.66). Phenological classification for grapevine genetic resources will help promote their utilization for research and targeted breeding of adapted cultivars.

Specified Source(s) of Funding: USDA-ARS Plant Genetic Resources Unit

4:15 PM – 4:30 PM

Diversity in First Year Phenotypic Traits of Wild Collected Oakleaf Hydrangea (*Hydrangea quercifolia* Bartr.) Seedlings

Andrew Sherwood*[1]; Lisa Alexander[2]; Matthew D. Clark[3]; Steven McNamara[4] and Stan C. Hokanson[3], (1)University of Minnesota - Dept. of Horticultural Science, (2)USDA-ARS, (3)University of Minnesota, (4)Minnesota Landscape Arboretum

Oakleaf hydrangea is a shrub with unique ornamental traits that are not available in other popular *Hydrangea* species such as exfoliating bark, intense fall color and deeply lobed leaves. Little is known about the variation in phenotypes in the wild germplasm of *H. quercifolia.* Moreover, woody ornamental breeding programs rarely begin with a comprehensive evaluation of the species but doing so allows the full range of phenotypic diversity to be assessed allowing for the optimal parental pool to be selected for breeding. In order to alleviate these two shortcomings, we sampled wild oakleaf hydrangea germplasm from across its range of occurrence in the SE U.S. and characterized the diversity in germination rate, compactness related traits (height and internode length), and midwinter cold hardiness (LT_{50} and percent survival at -35°C) using a laboratory based controlled freezing assay. Seed from 17 natural populations representing a latitudinal cline (from Florida to Tennessee) was germinated in 2018 and variation was evaluated in the seedlings' first year of growth. Significant variation in percent seed germination was found among populations, with the population means ranging from 14% to 97.3%. Height also varied significantly among populations and had a weak negative correlation with latitude ($r=-0.41$; $p<0.001$). Internode length was estimated by dividing plant height by node number and varied significantly among populations; shorter plants tended to have shorter internodes ($r=0.92$; $p<0.001$). Most seedlings had one main stem, however one family was identified with an increased number of branches. Significant variation for cold hardiness was found among populations with LT_{50} ranging from -27.1°C to -33.1°C and percent survival at -35°C ranging from 4.3% to 36.4%. Both metrics of cold hardiness correlated significantly with latitude ($r=0.72$; $p=0.003$). These seedlings will continue to be evaluated in Minnesota and Tennessee for additional phenotypic variation along with a broader sample collected from the entire native range of *H. quercifolia*. Representative seed samples and clones will be made available to breeders via the USDA National Plant Germplasm System.

Specified Source(s) of Funding: MN Ag Expt. Station, USDA NPGS Plant Evaluation Grant

4:30 PM – 4:45 PM

Reciprocal Differences in Pericarp Integrity of Seeds of Tropical-Adapted *Shrunken-2* Maize Lines and Evidence of Paternal Effect on a Tissue of Female Origin

Victor Olawale Adetimirin*; Victoria Edematie; Ayodeji Abe and Solomon A. Oyekale, University of Ibadan

Pericarp integrity is associated with seed vigour in *shrunken*-2 (*sh*-2) maize. Genetic improvement of the pericarp is one of the strategies for improving seed quality in *sh*-2 maize. Genetic information on pericarp integrity, inferred from leachate conductivity, was elucidated from seeds of 10 S_7 parental inbred lines derived from a tropicalized *sh-2* maize population, their testcrosses, and reciprocal crosses. Two- and four-month old seeds were assayed. Experimental design was completely randomized with three and six replications for two and four-month old seeds, respectively. Leachate conductivity of the inbred lines ranged from 32.2 to 113.3 µs/cm/g in two-month old seeds and 47.0 to 152.2 µs/cm/g in four-month old seeds, while for the testcrosses it ranged from 27.6 (UISS7 - female parent) to 148.3 µs/cm/g in two-month old seeds and 36.2 (UISS7 - female parent) to 227.4 µs/cm/g in four-month old seeds; differences among the entries within each group were significant (*P < 0.05*). Significant differences in leachate conductivity were obtained in nine each of the 15 and 14 pairs of reciprocal crosses in two- and four-month old seeds, respectively. Differences in leachate conductivity between pairs of significantly different reciprocal crosses ranged from 33.9 to 377.3 µs/cm/g with an average of 147.2 µs/cm/g in two-month old seeds and 119.0 µs/cm/g in four-month old seeds. Crosses involving Inbred Line UISS 7 did not show significant reciprocal differences. Crosses in which Inbred Lines UISS 9 and UISS 4 were used as female parents had high leachate conductivity; UISS 7 as male parent, however, reduced the leachate conductivity of crosses involving these lines. The increase in leachate conductivity of four-month old seeds over two-month old seeds averaged 31.6% for the inbred lines, 40.0% for the testcrosses and 20.9% for the reciprocal crosses. Correlation between leachate conductivity of two- and four-month old seeds for the parental inbred lines, testcrosses, and reciprocal crosses ranged from 0.86 and 0.96 ($P < 0.01$). Correlation coefficient values between leachate conductivity of inbred lines and their testcrosses were not significant. Genetic variation for pericarp integrity was present among the inbred lines. In addition to the presence of reciprocal differences, this study provides evidence of a role for the male parent in pericarp integrity, despite the female parent origin of the pericarp. The development of *sh*-2 hybrids with excellent pericarp integrity requires a careful choice of parents.

4:45 PM – 5:00 PM

Performance and Phytochemical Analysis of 22 Varieties of Pomegranate (*Punica granatum)* in West Texas

Triston Hooks*, Texas A&M AgriLife Research, Texas A&M University; Genhua Niu, Texas A&M AgriLife Research Center at El Paso, Texas A&M University; Haijie Dou, Texas A&M University and Youping Sun, Department of Plants, Soils, and Climate, Utah State University

Abstract

Pomegranate is a drought and salt tolerant crop and its fruit contain high levels of antioxidants that have many health benefits. Pomegranate has potential to be an alternative crop in areas where water availability is limited, such as west Texas. However, more than 500 different pomegranate varieties are estimated to exist worldwide. Little is known about which varieties are suitable to grow in the west Texas region. The objective of this research was to evaluate the performance of 22 varieties of pomegranate over three years (2016-2018) in a field trial in west Texas. Yearly data included phenology, yield, biochemical analysis, and biotic and abiotic stress resistance. There were significant variety differences for many response variables indicating high diversity among the 22 varieties tested. There were also significant effects for year indicating seasonal variation and continued maturation of the trees in the field plot. Results showed varietal differences in leaf budding but not anthesis and indicated that breaking dormancy could differ by as much as 10 days between varieties. Yield and fruit count results show differences in performance between varieties indicating that some varieties are suitable to grow in the west Texas region while others are not. Biochemical analysis of the fruit juice showed varietal differences in sugar content measured in BRIX which ranged from 14% to 17% but no significant differences were found in phenolic and antioxidant concentrations, although less than three years of data was available for these latter measurements. Varietal differences were observed for fruit split, sunburn, and fruit rot (heart rot), indicating that some varieties are more resistant to abiotic and biotic stress than others.

Specified Source(s) of Funding: USDA AMS Specialty Crop Block Grant Program (SCBGP)

5:00 PM – 5:15 PM

The Deceptive *Plumeria*: The Quest to Find Meaningful Characters to Delimit Species within a Genus

Kauahi Perez*[1]; Richard M. Manshardt[1]; Teresita D. Amore[2]; Richard A Criley[3]; Michael Kantar[1]; Sterling Keeley[1] and Kenneth W. Leonhardt[1], (1)University of Hawaii at Manoa, (2)University of Hawai'i at Mānoa, (3)University of Hawaii

Species of the genus *Plumeria* in the plant family Apocynaceae are used for ornamental, cosmetic, and ethnomedicinal purposes. However, only a few of the species, specifically *P. rubra*, *P. obtusa*, *P. pudica*, and their cultivated varieties, find their way into commercial use, while other potentially useful species remain untapped sources of horticultural, medicinal, and cosmetic value. Disagreement among collectors and taxonomists alike, combined with misused or unconfirmed appellations and lack of unambiguous morphological descriptors and molecular markers, has thus made it difficult to identify species. Hence, a combination of 43 descriptive morphological characters and five molecular regions (ITS2, partial *matK*, psbJ-petA, trnH-psbA, rpl32-trnL) were evaluated to determine their efficacy of identifying groups of taxa as species within this genus. Iterative principal component analysis (PCA) was used to determine informative morphological characters that could distinguish among *Plumeria* spp. Maximum likelihood (ML) and Bayesian inference (BI) methods were employed on separate and combined molecular data to determine the phylogenetic utility and species discriminatory abilities of these markers. A total of 103 samples representing 16 putative species and botanical varieties were used for these studies. Iterative PCA revealed

that some specimens formed distinct clusters, suggesting that certain taxa should be recognized as legitimate species, and verified that descriptive morphological characters will suffice for 8 out of the 11 *Plumeria* spp. examined in that particular data set. Molecular analyses revealed that rpl32-trnL provided the best phylogenetic signal and ability to discriminate 8 species clades, although other regions contained indels that were unique to different species. Concatenating rpl32-trnL with ITS2, trnH-psbA, and psbJ-petA enhanced tree resolution and phylogenetic signal. In addition, analyses confirmed that certain named species are in fact synonyms of *P. obtusa* or at least belong to the *P. obtusa* Complex. Further, analyses confirm that *P. caracasana* is not a synonym of *P. pudica*, and an accession known as 'Isabella' should be given consideration as a species. Although these individual molecular regions can be used as markers to distinguish *Plumeria* spp., there may be other molecular regions better suited for phylogenetic studies and species identification for this genus. Furthermore, the addition of quantitative, reproductive, and anatomical characters will likely enhance proper diagnosis of *Plumeria* species as a total evidence approach. In conclusion, the morphological characters and molecular markers used in this study can identify distinct morphological species in most cases.

Specified Source(s) of Funding: Plumeria Society of America, Southern California Plumeria Society, UH Manoa Graduate Student Organization

5:15 PM – 5:30 PM

Biodiversity and Antioxidant Properties in Genetic Enhancement of Wild Berry Germplasm

Samir C. Debnath[*1]; Dong An[2]; Sapan Tailor[2]; Dhrumit Bhatt[2]; David B. McKenzie[1]; Fereidoon Shahidi[2]; Kelly Ross[1] and Yaw L. Siow[3], (1)Agriculture and Agri-Food Canada, (2)Memorial University of Newfoundland, (3) Agricuture and Agri-Food Canada

The importance of dietary health-promoting fruit crops has led to the production of many berry fruits globally. Berry crops are rich in vitamin C, pectin and other bioactive compounds. They produce anthocyanins which have significant therapeutic value, including anti-inflammatory, antitumor, antiulcer and antioxidant activities. Maintenance, preservation and evaluation of wild berry germplasm are of prime importance for their utilization in maintaining biodiversity, proprietary-rights protection and for enhancing genetic improvement. The use of DNA-based markers allow direct comparison of different genetic material independent of environmental influences. Genetic diversity analysis in berry germplasm will facilitate reliable genotypes classification and identification of accessions with possible use in a breeding program. The current review deals with in-depth study of various aspects of molecular diversity analyses using a number of DNA markers. Progress in wild germplasm collection and their characterization at morphological and biochemical levels is also described. Identification of desirable genotypes for high antioxidant properties and genetic variation are essential to develop environmentally friendly cultivars suited to the consumers' needs.

Floriculture 2

Moderator: John M. Dole
North Carolina State University, Raleigh, NC, USA

4:00 PM – 4:15 PM

Vase Life Potential of Two Commercial *Linum Perenne* cultivars

David Tork[*]; Neil O. Anderson; Don Wyse and Kevin Betts, University of Minnesota

Domestication of wild perennial flax species (*Linum spp.*) is being explored as part of a large research collaboration at the University of Minnesota, the Forever Green Initiative. Projects in Forever Green encourage year-round cover on the Minnesota agricultural landscape through the development of novel perennial, biennial, and winter cover crop species. These crops provide ecosystem services which help mitigate the negative environmental impacts of agriculture, while also providing added value to farmers. Perennial flax would increase soil retention, improve water quality, and provide flowers for pollinators when most other crops are not flowering in the fall. There is interest in the horticulture industry for using perennial flax as an ornamental bedding plant and new cut flower crop, although the potential vase life is unknown. The objective of this research was to determine the vase life potential of perennial flax cultivars on the market. In Fall 2018, vase life was evaluated for two commercial *L. perenne* cultivars ('Sapphire' and 'Blue Flax'), which were grown in replicated trials at two locations in Minnesota. The experiment utilized two treatments: DI water (control) and floral preservative, each with three replications per plant. Vase life (d), number of flowers, flower longevity, flower type (pin/thrum), and flower diameter (mm) were recorded every 24h. Water loss (mL) was recorded weekly. The average vase life of 'Sapphire' and 'Blue Flax' across treatment groups was 9.0 and 9.4 days, respectively. Univariate between-subjects ANOVAs were conducted to compare the effect of genotype and treatment on vase life, average daily water loss by evapotranspiration (ET), total # flowers, and average flower size. There was a significant treatment effect on vase life ($p<0.001$), but not genotype ($p=0.127$), and their interaction was not significant ($p=0.203$). For average daily water loss by ET, the effect of treatment, genotype, and their interaction were significant ($p<0.001$). For the total number of flowers, both treatment and genotype were significant ($p<0.001$), although their interaction was not significant ($p=0.730$). Similarly, for average flower size, treatment and genotype were both significant ($p<0.001$) with an interaction that was not significant ($p=0.316$). This study represents the first known investigation into perennial flax vase life, and the protocols developed in this study will be used to screen a diverse array

of flax accessions in Summer 2019.

Specified Source(s) of Funding: Minnesota Agricultural Experiment Station

4:15 PM – 4:30 PM

Increasing Herbaceous Perennial Stock Plant Production of *Salvia Pachyphylla* and *Osteospermum* 'avalanche' with Applications of Three Plant Growth Regulators

Sean Markovic* and James E. Klett, Colorado State University

The objective of these experiments was to evaluate the response of two hard to propagate herbaceous perennials, *Salvia pachyphylla* 'Mojave Sage' and *Osteospermum* 'Avalanche', to repeated foliar applications of three plant growth regulators (PGR). The PGR were applied at two rates: 1) Ethephon (2-chloroethyl Phosphonic Acid) (200 and 400 mg·L^{-1} (ppm)) (Verve, Nufarm Americas, Inc., Alsip, IL), 2) 6-benzylaminopurine (250 and 500 mg·L^{-1}) (Configure; Fine Agrochemicals Limited, Worcester, U.K.), and 3) Gibberellins A4A7 (GA) & N-(phenylmethyl)-1H-purine 6-amine (50 and 100 mg·L^{-1}) (Fascination; Valent USA Corp., Fresno, CS). Data collected to evaluate PGR efficacy: vegetative growth (height and width index), vegetative cutting numbers, fresh weight and dry weight of the harvested vegetative cuttings were assessed. A secondary propagation study was conducted in synchronization to determine the PGR treatments effects on the rooting of vegetative cuttings taken from the treatments. No significant differences in propagation material, fresh or dry weights was observed in the first of two experiments for *Salvia pachyphylla* between treatments. Fascination significantly increased vegetative propagation material production for *Salvia pachyphylla* when compared to all other treatments in the second experiment. In the propagation study with *Salvia pachyphylla*, no significant difference in rooting percentage was observed after four weeks. Vegetative cutting harvested resulted in an 26% and 27% increase in number of vegetative cuttings with Fascination (50 or 100 ppm) treatments with *Osteospermum* 'Avalanche' when compared to the control. Fresh and dry weights of vegetative cuttings harvested resulted in no significant differences. Rooting experiments for *Osteospermum* 'Avalanche' resulted in no significant differences with all treatments, including the control; possessing high rooting percentages over 95%.

Specified Source(s) of Funding: USDA Specialty Crops Block Grant, Plant Select©, and Colorado Horticulture and Research Education Foundation

4:30 PM – 4:45 PM

Sub-Zero Temperatures Temporarily Preserve Vase Life and Quality of Cut *Paeonia Lactiflora* Pall. Hybrids

Nathan Jahnke* and John M. Dole, North Carolina State University

Growers and wholesalers can store cut flowers of *Paeonia lactiflora* Pall. (peony) hybrids for 4 to 8 weeks to fill seasonal production gaps. However, vase life and quality of stored flowers is often less than flowers freshly cut or stored for <4 weeks. Due to peonies' natural ability to withstand freezing temperatures prior to harvest, sub-zero temperatures may better preserve vase life and quality for longer durations than the industry standard of 0 to 1 °C. In year 1, cut stems of three peony cultivars: Festiva Maxima, Monsieur Jules Elie, and Sarah Bernhardt, were held at 3.5, 0.6, or -3.1 °C for 0 to 12 weeks. The industry standard, 0.6 °C, preserved vase life and other quality traits better than 3.5 and -3.1 °C. 'Festiva Maxima' was the least tolerant of storage with a vase life of 0, 4.1 and 1.0 days after 12 weeks at 3.5, 0.6, and -3.5 °C, respectively. 'Monsieur Julies Elie' was the most tolerant of storage at all temperatures. Specifically, at -3.5 °C, vase life was 5.3 and 3.2 d after 8 and 12 weeks, respectively. Sub-zero storage prevented weight loss similar to 0.6 °C. As storage duration increased the percentage of buds that fully opened decreased for all cultivars and temperatures, except 'Monsieur Jules Elie' held at 0.6 °C. Over 50% of 'Sarah Bernhardt' buds were unable to fully open after being held at -3.5 °C for 3 weeks. Across all temperatures, floral diameter of 'Sarah Bernhardt' decreased from 12 to 10 cm after 12 weeks of storage. During year 2, the sub-zero temperature was elevated to approximately -1 °C to alleviate loss of flower quality. Storage duration was extended to evaluate a storage period of 4 months, which would fill current gaps of peony production. Preliminary results show that sub-zero temperatures may be a viable alternative for storing cut peonies.

Specified Source(s) of Funding: North Carolina Specialty Crop Block Grant Program

4:45 PM – 5:00 PM

Application of *Pseudomonas Spp.* Increases Floriculture Crop Quality during Abiotic Stress

Michelle L. Jones* and Nathan P. Nordstedt, The Ohio State University

Low nutrient and post-harvest drought stress are two of the most limiting factors to ornamental crop quality; causing stunted growth and reduced flowering. Plant growth promoting rhizobacteria (PGPR) have the ability to stimulate plant growth during abiotic stress by enhancing macro- and micronutrient uptake, increasing the production of plant growth-promoting hormones, and reducing stress hormones like ethylene. Previous work has identified three *Pseudomonas* strains that can increase flower number and shoot biomass when applied to *Petunia* × *hybrida* 'Picobella Blue'. These three strains were then validated in a production scale experiment to evaluate the effects on growth promotion in *P. hybrida* 'Picobella Blue', *Impatiens walleriana* 'Super Elfin Ruby', and *Viola* × *wittrockiana* 'Delta Pure Red'. A low nutrient experiment was conducted with plants grown under constant fertigation with 25 mg L^{-1} N from 15-5-15 CaMg and treated with each of the three bacteria strains: *P. vranovensis* 15D11, *P. poae* 29G9, and *P. fluorescens* 90F12-2. In a second experiment plants were treated with each of the three bacteria strains and then subjected to drought stress five weeks after transplant. Negative controls for both experiments included application of uninoculated LB media. Plants were grown to the marketable stage and flower number and shoot biomass was recorded as an indicator of plant growth promotion. Application of each of the three strains resulted in an increase in shoot biomass of all three bedding plant species under both drought and low nutrient conditions compared to the negative control. *I. walleriana* plants grown under low nutrient conditions had higher leaf nitrogen, phosphorus, potassium, calcium, sulfur, and magnesium content compared to the untreated plants (i.e. negative control). All three bacteria strains also significantly increased flower number of *P. hybrida* after recovery from the drought stress. This work provides an efficient method to select and validate bacteria for their ability to increase floriculture crop quality under different abiotic stresses.

Specified Source(s) of Funding: American Floral Endowment, The OSU DC Kiplinger Floriculture Endowment

5:00 PM – 5:15 PM

Comparison of Substrate Silicon Amendments for Potted Roses

Jennifer Boldt*, USDA-ARS and James Altland, USDA-ARS, MWA ATRU

Silicon (Si) can alleviate abiotic and biotic stresses in plants. Substrate components and amendments, liquid fertilization, and foliar sprays can provide supplemental Si. Substrate amendments may supply an extended release of Si during production, but incorporation rates are not well elucidated. Our objective was to evaluate substrate amendments as potential Si sources for potted roses (*Rosa ×hybrida*). Amendments added to the peatmoss substrate included parboiled rice hulls at 5%, 10%, or 20% (by volume); ground parboiled rice hulls at 5%, 10%, or 20% (by volume); rice hull biochar at 1.5%, 3%, or 6% (by volume); steel slag (PlantTuff) at 2.37, 4.75, or 7.12 kg·m^{-3}; hydrous potassium silicate (AgSil) at 0.38, 0.76, or 1.14 kg·m^{-3}; and calcium silicate (wollastonite) at 0.39, 0.78, or 1.17 kg·m^{-3}. A non-amended control and a non-amended control fertilized with 2 mM potassium silicate at each irrigation were also evaluated. Initial substrate pH of each treatment was adjusted to 6.2 – 6.5. Rooted liners of rose 'Daniela' were transplanted into 11.5-cm pots, arranged in a completely randomized design with five pots per treatment, and grown for six weeks. Greenhouse air temperatures were 20.4 ± 1.0 °C day/16.3 ± 1.4 °C night, with a daily light integral of 12.2 ± 1.1 mol·m^{-2}·d^{-1}. Plants were fertilized with 20N-2.2P-12.4K at a concentration of 150 mg·L^{-1} N at every irrigation. Plant growth and quality (height, dry mass, root rating, and relative chlorophyll content) of all treatments were similar to the non-amended control. Leachate Si concentrations for the non-amended control and the 2 mM liquid potassium silicate treatments were 4.4 and 54.0 mg·L^{-1} after 2 weeks, 1.2 and 76.8 mg·L^{-1} after 4 weeks, and 0.3 and 83.3 mg·L^{-1} after 6 weeks, respectively. Leachate Si concentrations of the amendment treatments ranged from 12.1 to 42.7 mg·L^{-1} after 2 weeks, 10.9 to 31.1 mg·L^{-1} after 4 weeks, and 3.2 to 15.4 mg·L^{-1} after 6 weeks. Foliar Si concentration ranged from 180 mg·kg^{-1} in the non-amended control to 4732 mg·kg^{-1} in the 2 mM liquid potassium silicate treatment, but between 500 and 2051 mg·kg^{-1} for the substrate amendment treatments. Foliar Si increased as incorporation rate increased.

5:15 PM – 5:30 PM

Evaluating Effects of Iron and Phosphorus Deficiency Stress on Root Zone Acidity-Basicity and Adaptive Root Responses with Floriculture Species Grown in Hydroponics and Peat-Based Substrate

Ryan Dickson*, University of Arkansas

Objectives were to evaluate (1) changes in root zone pH and cation/anion uptake and (2) the potential to enhance root ferric iron (Fe^{3+}) reductase and phosphatase activity in response to low iron and phosphorus supply for geranium (*Pelargonium × hortorum*), impatiens (*Impatiens wallerana*), and petunia (*Petunia × hybrid*) grown hydroponically and in peat-based substrate. In one experiment, plants were grown hydroponically in a controlled-environment growth chamber for 21 days in three nutrient solutions containing 7.14 milli-equivalents (mEq)·L^{-1} NO_3-N with all essential plants nutrients (control), with no iron (-Fe), or with no phosphorus (-P). In the second experiment, plants were grown in a greenhouse in peat-based substrates and fertilized with the same nutrient solutions for 28 days. At the end of both experiments, plants developed visual symptoms of iron and phosphorus deficiency when supplied with -Fe and -P nutrient solutions, respectively. In hydroponics, all species raised root zone pH except for geranium, which decreased pH 3.6 units when supplied with -Fe solution and resulted in no pH change with –P solution. Cation/anion uptake ratio for geranium increased from 1.02 (control) to 1.55 and 1.79 when supplied -Fe and -P solutions, respectively, but was not affected for the other species. Iron reductase activity changed by 40%, 36%, and -14% for geranium, impatiens, and petunia, respectively, when supplied -Fe compared to the control solution. Phosphatase activity changed by 167%, 42%, and 31% for geranium, impatiens, and petunia, respectively, when supplied -P compared to the control solution. In substrate, plant species increased root zone pH with each nutrient solution type. Cation/anion uptake ratio for geranium and impatiens was greater when supplied -Fe and -P solutions compared to the control, but was not affected with petunia. It is likely that potential acidification from geranium with –Fe was highly localized in the rhizosphere and therefore not detected by measuring changes in bulk substrate-pH. In horticultural practice, geranium typically show lower susceptibility to iron deficiency at high pH compared to petunia, which may result from the ability of geranium to acidify the rhizosphere and enhance ferric iron reductase activity in response to low iron supply.

5:30 PM – 5:45 PM

Investigating the Effects of Duration and Timing of Far-Red Radiation Treatments on Seedling Growth and Subsequent Flowering of Floriculture Transplants

Yujin Park* and Erik S. Runkle, Michigan State University

Including far-red (FR, 700-800 nm) radiation in indoor lighting can promote seedling growth and, in at least some long-day plants, can accelerate subsequent flowering. Here we investigated how the duration and timing of FR treatments during the seedling stage influence growth and subsequent flowering of common floriculture transplants. Seedlings of dianthus (*Dianthus chinensis*), geranium (*Pelargonium ×hortorum*), petunia (*Petunia ×hybrida*), and snapdragon (*Antirrhinum majus*) were grown at 20 °C under an 18-h photoperiod with a photon flux density of 32 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of blue and 128 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of red radiation. The 27 d seedling stage was divided into three equal phases, and 32 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of FR radiation was provided for one-third, two-thirds, or the entire seedling stage. Seedlings were then transplanted and grown in a common greenhouse environment until flowering at 20 °C with a 16-h photoperiod. Generally, plant height increased (by 20 to 86%) as the duration of exposure to FR increased, and as the timing of FR radiation was delayed. However, there was little to no effect of FR treatment on leaf number and total leaf area in any species. In snapdragon and petunia, relative leaf chlorophyll concentration decreased when FR was delivered during the first and third phases, the last two phases, or the entire seedling stage. In petunia, 9 d of FR during the second or third seedling phase also reduced relative leaf chlorophyll concentration. Compared to without FR, shoot dry weight increased when FR was delivered during the entire seedling stage for petunia by 60%, or during the last two phases for geranium by 32%. The effects of the FR treatments on subsequent flowering will be also presented.

Specified Source(s) of Funding: This work is supported by American Floral Endowment.

Postharvest 2

Moderator: Marlee Trandel
North Carolina State University, Raleigh, NC, USA

4:00 PM – 4:15 PM

Amaranth: A Model Crop for Testing Imperfect Storages

Sangeeta Chopra*, Indian Agricultural Research Institute; Randolph Beaudry, Michigan State Univ and Norbert Mueller, Michigan State University

We wanted to find a way to compare the functionality of imperfect storage structures constructed in areas where access to electricity and humidity modification is difficult. We evaluated leafy amaranth as a possible model crop that can be used as a tool for testing the efficacy and performance of storages that do not hold constant conditions of temperature and humidity throughout the day or throughout the year. This is because the crop has markedly visible and easily measurable features that change with storage including leaf senescence, abscission and yellowing. These features can be measured without expensive tools, permitting ill-fitted laboratories to evaluate their storages and will permit comparison of storages at any location. Amaranth thrives in hot weather and is best stored at 0 to 5 °C and 80-90% RH. In Delhi, India, we used the amaranth to evaluate a solar refrigerated evaporatively cooled (SREC) store, an evaporatively cooled (EC) store, and an ordinary (ambient) room during the summer when daily high temperatures were approximately 40 °C and nighttime temperatures were approximately 30 °C. The SREC room, while it is an advance over the standard EC room, could only achieve a low temperature of 9 °C during the day and 14 °C at night, with little control over humidity. Nevertheless, we found, as expected, desiccation, leaf abscission and yellowing was much more rapid in EC and ordinary room compared to SREC stores. We propose that amaranth would make an effective model plant for comparing storage efficacies and suggest similar approaches for widely grown fruit might be similarly useful.

Specified Source(s) of Funding: USAID

4:15 PM – 4:30 PM

Seed Browning Induced By Methyl Salicylate and Reduced By Methyl Jasmonate in Harvested Hot Pepper (*Capsicum annuum* L.)

Ji Eun Seo*, Department of Plant Science, Research Institute of Agriculture and Life Sciences, College of Agriculture and Life Sciences, Seoul National University and Eun Jin Lee, Department of Plant Science, College of Agriculture and Life Sciences, Seoul National University

Peppers are a subtropical crop, they suffer from a chilling injury in the postharvest process. The commercial values of peppers are lowered due to the seed browning which is one of typical chilling symptoms caused by the chilling temperature. This study was performed to investigate the seed browning of the hot pepper due to chilling injury and related substances and genes in aspect of the hormonal interactions. The hot pepper 'JoongAng' was placed in four closed chambers: control, exo-methyl jasmonate (MeJA) treatment, exo-methyl salicylate (MeSA) treatment, and combination (MeJA+MeSA) treatment. The peppers were treated with 50 μM of MeJA and 250 μM of MeSA at 20 °C for 16 hours. After the treatments, the peppers were stored for 25 days at 2 °C. The rate of seed browning as a measure of chilling injury, the content analysis of endo-salicylate and endo-jasmonate, and the qPCR of genes involved in the synthesis and signaling of jasmonate and salicylate were analyzed. The seed browning rate was increased by the MeSA treatment and decreased by the MeJA treatment. The difference in the content of salicylate was not observed in all treatments. The jasmonate content analysis was carried out but was not quantifiable due to their small amounts. While the genes related to ROS scavenging were highly expressed in the MeSA treatment, the genes related to the jasmonte systhesis were highly expressed in the MeJA treatment according to the qPCR results.Thus, it can be inferred that a chilling injury in hot peppers is induced by the MeSA treatment and reduced by the MeJA treatment. This work was supported by the Basic Science Research Program through the National Research Foundation (NRF, 2016R1A1A1A05919210) of Korea funded by the Ministry of Education, Science, and Technology (MEST).

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4:30 PM – 4:45 PM

Identifying Optimum Storage and Handling Conditions for Sweet Potato Slips

Joseph Rundquist*[1]; Jason J. Griffin[1]; Cary L. Rivard[2] and Eleni D. Pliakoni[1], (1)Kansas State University, (2)kansas state university

Sweetpotato [Ipomoea batatas (L.) Lam.] is a tropical perennial native to the Americas and is suited for both large and small-scale, organic and conventional production. Sweetpotato is propagated vegetatively through stem cuttings known as slips. In the United States, slip production is concentrated in the Southeast and sweetpotato growers in regions such as Kansas are reliant plant material that is shipped from outside the region. Transportation and storage conditions can result in low quality slips that may perform poorly after being planted in the field. Little information regarding proper postharvest storage and handling practices for sweetpotato slips is available. Furthermore, shipping and packing practices vary among slip producers. The objectives of this study were to identify the optimal storage and shipping conditions related to temperature and packaging for sweetpotato slips and identify the threshold of slip quality that leads to poor field performance. Slips of ‘Orleans’ were harvested at the John C. Pair Horticultural Center (Haysville, Kansas, USA) and transported to the Postharvest Physiology Laboratory at Kansas State University Olathe (Olathe, Kansas, USA). Upon arrival the slips were cut to size and placed into small waxed cardboard boxes with or without nylon film liner. Boxes were stored in environmental chambers at three different temperatures: 16°C, 22°C, 30° at 65% relative humidity. An overall quality rating scale was developed, which rated slips from 1 to 1 9 (1- completely senesced to 9- field fresh slip). Quality was monitored throughout storage by measuring chlorophyll fluorescence, color, water loss, respiration, and chlorophyll content. A complementary field study was conducted to determine the performance of slips at quality ratings 9, 7, 5, 3, 1. Slips stored at 16°C had the longest storage life, maintaining marketable quality up to 10 days. Followed by 8 days for 22°C and 6 days for 30°C. After 4 days of storage samples stored without a liner exhibited higher average rates of water loss (11.5%). This difference was significant at all temperatures between liner and no-liner (16°C p=.0133, 22°C p=.0042, 30°C p=.0025.) The results of this work show that temperature and the addition of a liner play a critical role in maintaining quality and freshness of sweetpotato slips. Information from this study increases postharvest knowledge of sweetpotato slips with hopes to aid in creating new standardized shipping practices. Ultimately, leading to increased availability of quality planting material for sweetpotato producers in the Midwest

Specified Source(s) of Funding: NCR-SARE Grant

4:45 PM – 5:00 PM

Viability of Sublethally Injured Coliform Bacteria on Fresh-Cut Cabbage Treated with Disinfectant and Stored in MAP

Hidemi Izumi*; Yotaro Hurukawa; Asuka Kamikokuryo; Jin Sakamoto and Ayano Inoue, Kindai University

Chemical disinfectants can induce bacteria to be in a sublethally injured state. We initially determined the effects of individual disinfectant treatments that included electrolyzed water (50 ppm available chlorine), alcohol agent (5% ethanol), calcined calcium agent (91% calcium oxide), and fumaric acid agent (20% fumaric acid), followed by sequential treatments with these disinfectants on the induction of sublethally injured coliform bacteria present on shredded cabbage. Subsequently, we evaluated the viability of injured coliforms on shredded cabbage treated with the combination of two disinfectants and then stored in a modified atmosphere packaging (MAP) at 5ºC for 5 days. The thin agar layer (TAL) method was used to recover and enumerate injured bacteria. In an in vitro study using a pure culture of *Escherichia coli*, it was found that injury of *E. coli* ranged from 66 to 100% in either electrolyzed water containing 1-2 ppm available chlorine, 3-9% alcohol agent, 0.03-0.1% calcined calcium agent, or 0.02% fumaric acid agent. In an in vivo study using shredded cabbage, coliform counts were reduced as the concentration of each disinfectant increased, and only the treatments with electrolyzed water containing 25-35 ppm available chlorine or 0.1% fumaric acid agent caused sublethal injury at a 51-58% level. When electrolyzed water containing 25 ppm available chlorine was combined with either 2% alcohol agent, 0.05% calcined calcium agent, or 0.1% fumaric acid agent, these combinations of the disinfectants reduced the coliform counts markedly and did not induce sublethal injury to coliforms on shredded cabbage. Shredded cabbage, nontreated or treated with electrolyzed water followed by either alcohol agent, calcined calcium agent, or fumaric acid agent, was stored in a MAP (an equilibrium of 8% CO_2/10% O_2 for nontreated samples and 4% CO_2/15% O_2 for treated samples). Coliforms injured at a 55-78% range were detected on samples nontreated and treated with electrolyzed water followed by fumaric acid, and coliform counts increased more than 1 log from the initial counts after 5 days of storage. In comparison, the treatment with electrolyzed water followed by either the alcohol agent or calcined calcium agent prevented bacterial proliferation and occurrence of sublethal injury throughout the storage period. These results indicated that the combination of two disinfectants would be helpful in reducing bacterial counts and suppressing the degree of sublethal injury on fresh-cut cabbage after treatment and during subsequent MAP storage.

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5:00 PM – 5:15 PM

Understanding Hollow Heart Formation in 'Liberty' Watermelon

Marlee Anne Trandel*[1]; Penelope Perkins-Veazie[1]; Jonathan R. Schultheis[1]; Chris Gunter[1] and Suzanne Johanningsmeier[2], (1)North Carolina State University, (2)USDA-ARS

Hollow heart (HH), a disorder where a void appears in the placental tissue in triploid watermelon, develops randomly with growing season. This internal defect negatively plagues growers and industry as fruit with moderate to severe cases cause load rejection. Previous research has indicated increased tissue density (the number and size of cells) in watermelon cultivars increases fruit firmness and decreases incidence of internal disorders. The goal of this work was to induce HH formation in triploid watermelon in the field, assess tissue density via confocal micrographs, and characterize cell wall polysaccharide content in fruit with and without HH. 'Liberty', a watermelon cultivar susceptible to HH, was transplanted in Clayton NC with diploid pollenizers (SP-6) planted at 6, 9 and 12 m down the tiers to induce HH. This system yielded 52% HH. Fruit were harvested, cut longitudinally and resistance to puncture measured in heart tissue. Roughly 100 g of heart tissue was saved for confocal microscopy and cell wall polysaccharide assays. The number and cross sectional area size (μm^3) of cells in control fruit and fruit with moderate to severe HH were counted in confocal micrographs using ImageJ software. Frozen watermelon tissue was homogenized and washed with acetone, ethanol and methanol to yield alcohol insoluble residues (AIR). Water soluble and water insoluble pectins were isolate from AIR. Alcohol insoluble residues were also reduced, derivatized, hydrolyzed, methylated for linkage assembly, and acetylated for a GC-MS based compositional analysis of monosaccharide building blocks. While the number of fruit cells were not affected by incidence or severity of HH, fruit with moderate HH had the largest cells at 102,873 μm^3 ($P < 0.001$). In control (no HH) watermelon, highest levels of galactose, glucose, xylose, arabinose, and rhamnose cell wall monosaccharides are expected. We hypothesize that fruit with HH have less complex pectins causing separation in fruit cells and a decrease in cell density leading to the disorder. Therefore, we predict that the AIR pectins from watermelon flesh in fruit found with no HH will contain higher amounts of xylose and arabinose monosaccharides and total pectins.

Specified Source(s) of Funding: USDA-SCRI 2016-51181-25404

5:15 PM – 5:30 PM

Effect of Cooling Methods on Postharvest Quality of Commercial Broccoli Cultivars Grown in Florida

Carina Theodore*; Steven A. Sargent; Jeffrey K. Brecht and Lincoln Zotarelli, University of Florida

Broccoli (*Brassica oleracea* L.) is a cool season vegetable that originated in Mediterranean Europe. A member of the Brassicaceae family, per capita consumption of broccoli has dramatically increased in the United States from 1.4 pounds in 1980 to 7.1 pounds in 2017, totaling approximately 2 billion pounds for the latter year. Broccoli is highly perishable due to its high respiration rate and rapidly loses quality under inappropriate handling temperatures. The purpose of this study was to evaluate the effect of commercial hydrocooling (HY), forced-air cooling (FA) or slushed-ice cooling (SI) on the quality and shelf-life of two commercial broccoli cultivars ('Marathon' and 'Eastern Crown') grown in northeast Florida during the early spring season. Following HY and FA, the crowns were wrapped in plastic film bags; all treatments were stored in waxed, corrugated cartons at 1°C for 7 d (simulating commercial storage), then transferred to 5°C for 8 d (simulating retail handling). Comparing the compactness of the two cultivars using a subjective rating scale (1= most compact and 5=loose florets), 'Eastern Crown' was firmer during storage (1.3) compared to 'Marathon' (1.7) but using a texture analyzer there was no significant force difference between them (51.65 N and 50.86 N respectively). Furthermore, ascorbic acid and carotenoid contents were higher in 'Eastern Crown' (148.5 and 21.2 mg/100 g FW) than 'Marathon' (131.6 and 17.1 mg/100 g FW). 'Marathon' had less chlorophyll breakdown during storage, as shown by higher a* (green color), and higher moisture content and lower dry matter content than 'Eastern Crown'. During storage (0, 7, 11, 15 days), there was a decrease in crown firmness, texture, overall quality, and color values (L*, a*, b*, h*) of the broccoli heads. There was a reduction in the ascorbic acid and chlorophyll contents, but carotenoid content varied over the time. Dry matter and moisture contents were not significantly different.The cooling treatment significantly affected head compactness during storage, where HY and FA wrapped crowns had less crown softening compared to SI, but no effect in nutritional composition or head color. HY or FA broccoli and wrapping can help growers reduce cooling costs and provide a more favorable product for retailers while eliminating the problem of melting ice during transport of SI broccoli to the market.

5:30 PM – 5:45 PM

Understanding of Seed Browning Mechanism Induced By Chilling in Pepper through Targeted/Untargeted Metabolomics and Gene Expression Analysis

Jeong Gu Lee*, Department of Plant Science, Research Institute of Agriculture and Life Sciences, College of Agriculture and Life Sciences, Seoul National University and Eun Jin Lee, Department of Plant Science, College of Agriculture and Life Sciences, Seoul National University

Pepper (*Capsicum annuum* L.) is one of the most important economic crops, which is sensitive to low temperature, and chilling injury easily occurs. Seed browning, which is a typical chilling injury symptom, is a major problem in the storage and distribution of hot pepper. This study was conducted to clarify the mechanism of seed browning during cold storage of pepper from the viewpoint of metabolic changes. The samples were stored at 2 °C and 10 °C for 10 days, 20 days and 30 days immediately after harvesting and polar phase compounds, phenolic compounds, fatty acids, and free amino acids were analysed. Metabolic analysis showed that the contents of tyrosine and phenylalanine, which are substrates of polyphenol oxidase and phenylalanine amino lyase, which are related to enzymatic browning, are high at 2 °C storage. Glutamate, gamma-aminobutyric acid (GABA), and isoleucine were analyzed in response to low-temperature stress. GABA was synthesized from glutamate, and jasmonic acid-Ile (JA-Ile), an active form of JA, was formed and activated by the JA signaling pathway. In order to maintain the physical properties of the cells in response to low temperature stress, the content of sucrose and glucose, which are monosaccharides and disaccharides, was found to increase. The negative correlation between linoleic acid and palmitic acid resulted in low lipid peroxidation, was converted to saturated fatty acid. Therefore, this study could explain the mechanism of the browning process and the response to cold stress in the low-temperature stored pepper from the viewpoint of metabolism, and might be a basis for improving the quality after harvest of the hot pepper and developing the low-temperature resistant pepper as new cultivars. This work was supported by the Basic Science Research Program through the National Research Foundation (NRF, 2016R1A1A1A05919210) of Korea funded by the Ministry of Education, Science, and Technology (MEST).

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Vegetable Crops Management 2

Moderator: Ajay Nair
Iowa State University, Ames, IA, USA

4:00 PM – 4:15 PM

Anaerobic Soil Disinfestation: Supplementary Soil Amendments Impact on Soil Nutrient, Plant Growth, Nutrient Uptake, and Yield in Fresh-Market Tomato

Francesco Di Gioia*[1]; Bodh R. Paudel[2]; Cristina Pisani[3]; Jason C. Hong[3]; Xin Zhao[2]; Monica P. Xiomara Ozores-Hampton[2] and Erin N. Rosskopf[3], (1)The Pennsylvania State University, (2)University of Florida, (3)USDA-ARS

Proposed as a biological strategy for control of soilborne pests and pathogens, anaerobic soil disinfestation (ASD) is implemented by amending the soil with an easily-decomposable source of carbon (C) and other organic amendments combined with water soil saturation and polyethylene mulching. The ASD method developed in Florida relies primarily on the combined use of molasses (M) as the C source and composted poultry litter (CPL) as a supplementary organic amendment. While this approach is effective, the use of CPL poses a series of issues related to the high content of phosphorus (P), food safety, and limited availability. A study was conducted to investigate the potential of composted yard waste (CYW) as a substitute for CPL and to test Soil Symphony Amendment (SSA,) a commercial biological soil management strategy, in comparison with ASD, chemical soil fumigation (CSF), and an untreated check. Eight alternative soil management strategies were evaluated for their effects on soil nutrient availability, plant growth, nutrient accumulation, and yield in a fresh-market tomato crop during the fall 2016 season in Immokalee, FL. ASD applied using 6.93 m^3 ha^{-1} of M and 11 Mg ha^{-1} of CPL (ASD0.5) led to the highest availability of K, P, Mg, and Na throughout the growing season and a higher availability of S toward the end of the growing season. Substituting CPL with CYW at the rate of 26.9 Mg ha^{-1} (CYW1+M) or 13.45 Mg ha^{-1} (CYW0.5+M) provided lower but still adequate levels of macronutrients compared to ASD0.5. ASD0.5 resulted in the lowest soil NO_3-N content during the first 14 days of treatment. Limited and inconsistent differences were observed between soil treatments regarding soil micronutrient content. At 30 and 60 days after planting (DAP), ASD0.5 plants had the highest total plant biomass. At 60 DAP similar levels of biomass were produced by CYW0.5+M and CSF plants, while a slightly lower plant biomass resulted from CYW1+M. The higher plant biomass and availability of nutrients observed in ASD0.5, CYW0.5+M, CSF, and CYW1+M also resulted in a higher accumulation of nutrients in the plant tissues as

compared to the other treatments. Marketable fruit yield was highest from ASD0.5 plants, but CSF, CYW1+M, and CYW0.5+M plants provided similar yields. It is concluded that, substituting CPL with CYW may reduce the risks of nutrient loss, especially for P, during the ASD treatments without reducing plant growth and yield.

Specified Source(s) of Funding: USDA - Agricultural Research Service Areawide Project on Anaerobic Soil Disinfestation

4:15 PM – 4:30 PM

Influence of Soil Heating and Low Tunnel Covers on Basil and Snap Bean Production in a High Tunnel.

Harlene Hatterman-Valenti* and Collin Auwarter, North Dakota State University

High tunnels have enabled North Dakota growers to initiate production much earlier in the spring when compared to filed production. A field study was conducted at the North Dakota State University Horticulture Research Arboretum to evaluate the influence of three soil heating treatments (no heat, soil heating coils, and infrared heat mats) and three low tunnel coverings (clear plastic, 1 oz. and 2.5 ounce frost blankets) on the growth and production of two basil cultivars (Elenor and Everleaf) and two snap bean cultivars (EZ Pick and Amethyst Purple) when transplanted or seeded at three timings (T1=April 9, T2=April 30, and T3=May 21). Low tunnel coverings were used on the first timing only and remained over plots until April 30. The soil heating cables and infrared heating mats had internal thermostats set to shut off when soil temperature reach 75 F and thus were used until the end of the experiment. Dataloggers were used to record soil and air temperatures every 30 minutes. Thermistors were placed at the 6-inch height within a treatment row and at a 4-inch dept in the soil within the row to record treatment differences. In general, the clear plastic low tunnel resulted in higher daytime air temperatures, especially on sunny days, while the soil heating with row covers resulted in slightly higher air temperatures at night. The greatest snap bean yield occurred when seed were planted T1 with soil heating cables. This yield was greater than yields for beans seeded T1 no heat, and bean planted T3 regardless of the heat source. The greatest basil yield occurred when transplanted T1 with soil heating cables. This yield was greater than yields for basil from all other timings and heat sources. Future research will examine other cold sensitive vegetables as well as economics related to even earlier transplanting or seeding schedules.

Specified Source(s) of Funding: North Dakota Specialty Block Grant funded part of the research associated with this abstract

4:30 PM – 4:45 PM

Sustainable Production and Utilization of Ten Selected Underutilized Vegetables Towards Healthy Diets and Nutritional Security in Nigeria

Mary Kemi Kemi Idowu*[1]; Christianah Tinuola Oladoye[1]; Durodoluwa Jospeh Oyedele[1]; Ojo Kolawole Adekunle[1]; M. Idowu[2]; Kehinde Taiwo Taiwo[1] and Odunayo Clement Adebooye[3], (1)Obafemi Awolowo University, (2)University of Manitoba, (3)Osun State University

The importance of the underutilized vegetables of southwest Nigeria for their nutritional and therapeutic ventures is rapidly increasing. Ten of the vegetables : *Solanum macrocarpon* (Igbagba), *Amaranthus viridis* (Tete atetedaye), *Crassocephalum crepidoides* (Ebolo), *Solanum nigrum* (Odu) , *Solanum Spp.* (Ogunmo), *Solanecio biafrae* (Woorowo), *Vernonia amygdalina* (Bitter leaf), *Telfairia occidentalis* (Ugwu), *Curcubita pepo* (Elegede) and *Trichosanthes cucumerina* (Tomato Elejo) were examined for there for growth, pest infestation, nutrient and biochemical qualities.

An experiment was established at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria in 2012. Soil physical and chemical properties were analyzed. Organic fertilizer and urea were applied at 40 kg N ha^{-1} each to supply a total of 80 kg N ha^{-1}. Pests' infestation on the vegetables were recorded. The nutrient and biochemical compositions of the vegetables were evaluated. The medicinal uses of the vegetables by people were documented.

The result showed that the nutrient composition of the vegetables for calcium ranged from 377-3312 mg kg^{-1}, magnesium from 1297-4652 mg kg^{-1}, Iron from 198-912 mg kg^{-1}, zinc from 53-152 mg kg^{-1} and copper from 4.7-30.1 mg kg^{-1}, the total carotenoids ranges from 22.4-46.2 mg/100g DM, phenolics from 38-66 GAE/100g DM, Tannins from 49-60 mg/100g DM, Flavonoids from 40-66 CE eq./100g and phytate from 2-4.2 mg/100 DM.

It was concluded that *Curcubita pepo* was more drought tolerant and most attacked by pests, with the highest value for iron and zinc. *Trichosanthes cucumerina* had the highest values for all the biochemical properties, except the phytate. Due to the effectiveness of the vegetables for treating different ailments and diseases, there is the need to intensive its production and consumption and at the same time develop standard methods for validating some of the medicinal claims.

Specified Source(s) of Funding: IDRC FATDC Grant No.: 106511

4:45 PM – 5:00 PM

Organic and Synthetic N Rate Effects on Winter Squash Production and Fruit Quality

Zachary D. Hayden* and Colin Phillippo, Michigan State University

Reducing the risk that vegetables grown for baby food (including winter squash) exceed nitrate thresholds at harvest is a current challenge for some processors. Nitrate accumulation in vegetables is influenced considerably by N fertilization, but other factors such as cultivar, timing, weather, soils, and plant stress can also play a role. The objective of this study was to evaluate the effects of N fertilization rate and source (synthetic vs. organic) on winter squash yield and fruit quality, including fruit nitrate concentration, brix, and vitamin A content. An on-farm experiment (RCBD with 4 replications) was conducted in 2017 and 2018 in an irrigated butternut squash (*cv. Ultra*) field on sandy soils in Michigan. Treatments included three rates of total plant available N (83, 137, and 190 kg N ha^{-1}) each consisting of 29 kg N ha^{-1} applied with the planter (10-34-0 and UAN 28%) and the remainder of the N applied either as urea (46-0-0) at sidedress or as pelletized chicken manure applied shortly after planting. To track the effects of N treatments on fruit quality over time, squash were subsampled 4 and 2 weeks pre-harvest, at harvest, and following 4 and 8 weeks in storage. Equivalent maximum yields were achieved regardless of whether post-planter N was supplied as urea or pelletized chicken manure. In 2017 only, manure yielded less than urea at 83 kg N ha^{-1}, but produced equivalent maximum yields as urea at 137 and 190 kg N ha^{-1} rates. The significantly lower yield for manure versus urea at the 83 kg N ha^{-1} rate may be a result of lower than expected N availability from the manure or greater N losses due to earlier application. Higher N rates were correlated with greater nitrate accumulation in squash fruit; however, only the highest rate of N (190 kg N ha^{-1}) applied as urea exceeded processor thresholds at harvest in one year. Fruit nitrate declined rapidly and brix levels increased in the month leading up to harvest, suggesting delaying harvest could be an effective strategy to deal with high nitrate squash fields. We observed little evidence that N rate or source substantially impacted brix or vitamin A content at harvest or during storage. While we saw no evidence that current year manure applications increase risk of nitrate accumulation relative to urea, N availability from legacy manure applications need to be considered when determining appropriate N fertilization rates.

5:00 PM – 5:15 PM

Effect of Row Cover Materials and Cultivars on Broccoli Yield and Quality

Ajay Nair*; Moriah Bilenky and Kristine M. Lang, Iowa State University

An important challenge in broccoli production is the intensive use of pesticides (conventional and organic), to manage pests such as cabbage loopers, imported cabbage worm, flea beetles, and cabbage aphids that cause immense damage by direct feeding and defoliating the plant. Many conventional/sustainable growers use spun-bond polypropylene row covers (Agribon, Reemay) to insure early harvest and exclude pests. Although they help with pest exclusion, they can overheat plants and must be pulled off by early summer, leaving the crop exposed to pests. This study conducted at the Horticulture Research Station, Ames, IA evaluated a new nylon-mesh row cover material (Protek net) that could be used to extend the growing season and protect plants from insect pests. The study investigated the effect of three row cover treatments (Agribon, Protek net, or no-cover) and six broccoli cultivars (Asteroid, Emerald Star, Green Gold, Green Magic, Gypsy, and Luna) on crop growth, yield, and head quality. The experimental design was a split plot randomized complete block design with row cover treatments as the whole and cultivars as the subplot factor with four replications. There were no significant differences in broccoli yield between row cover treatments, however, cultivars had a significant effect on yield with 'Green Gold' and 'Emerald Star' producing higher marketable yields than 'Green Magic', 'Gypsy', and 'Luna'. Row cover treatments did not affect average head diameter. Differences existed between cultivars with head diameters ranging from 10.4 to 14.5 cm. 'Green Magic' had the lowest head diameter when compared to Asteroid, Emerald Star, Green Gold, and Luna. Row cover treatment was significant for hollow stem. No-cover treatment had heads with lower hollow stems than Agribon treatment. Between cultivars, 'Gypsy' and 'Asteroid' had the highest and 'Emerald Star' had the least number of heads with hollow stem.

The study shows that Protek net and Agribon could be successfully utilized to mitigate insect pest damage in broccoli production. Specially, with Protek net, there is an added advantage of zero insecticide applications as the netting can remain on the crop until harvest. Cultivars play a critical role in broccoli production and growers should utilize appropriate cultivars that are better adapted to their growing region. 'Emerald Star' and 'Green Gold' produced higher number of marketable heads and lower number of non-marketable heads. Soil Boron concentration should also be taken in to consideration as it has direct implications on hollow stem.

Specified Source(s) of Funding: Iowa Department of Agriculture and Land Stewardship Specialty Crop Block Grant

5:15 PM – 5:30 PM

Utilization of Vermicomposts in Non-Circulating Hydroponics System and Their Effects on the Growth and Yield of Lettuce and Tomato

Norman Arancon*; John Dean Arancon and Chad Converse, University of Hawaii at Hilo

Vermicomposts are stabilized organic matter produced by interaction of earthworms and microorganisms. It has been well documented that their use in horticulture as organic amendment, as substitute or additive, for greenhouse and field crops increases growth and yield and suppresses pests and diseases. The production of its liquid counterpart commonly referred to as 'teas', used either soil drench or spray, have produced similar results on a variety of greenhouse and field crops. However its utilization and effects in hydroponics systems are still unknown. Low concentrations of vermicompost teas, produced from food wastes, at rates of 1.6% and 3.2% for lettuce and 0.14%, 0.28% and 0.56% for tomatoes were investigated as additive and supplement in static hydroponic systems. Vermicompost teas significantly increased lettuce yields when concentrations of nutrient solutions were reduced to 25% and 50% of the recommended full rate for nutrient solutions compared to treatments without vermicompost teas. Even lower concentrations of vermicompost teas increased tomato yields significantly as a supplement in reduced nutrient solutions of 50%. The presence of a combination of trace amounts of plant hormones such as auxins, cytokinins, gibberellins and humic acids in vermicomposts teas are likely the responsible factor that increased yields of lettuce and tomato in static hydroponics systems with lower concentrations of nutrient solutions.

Specified Source(s) of Funding: County of Hawaii R and D

Undergraduate Student 1

Moderator: Alyssa Palmer
Department of Plants, Soils, and Climate, Utah State University, Logan, UT, USA

4:15 PM – 4:30 PM

A Look at Bans on the Public Consumption of Tree Nuts

Mason Goolsby*; Ben Campbell; Julie Campbell; Vanessa Shonkwiler and Adam Rabinowitz, University of Georgia

Per capita tree nut consumption in the U.S. has trended upward over the past decade. However, nuts, both tree and field, have seen potential markets shrink as nut bans have been implemented throughout the U.S. The purpose of this study was to assess where nut bans have been implemented (e.g., schools, workplaces, etc.), especially as the bans relate to tree nuts. Using an online survey of around 1,100 respondents throughout the Midwest we examine which tree nuts have been banned in various locations. Results indicated schools were the most prevalent place nuts were banned followed by work, then other locations. Further, even though peanuts are most often perceived as the major nut that is banned, respondents reporting bans indicated that all nuts were more likely to be banned than individual nuts. Notably, for workplaces, tree nuts were more likely to be banned than peanuts when individual bans were imposed. Thereby, this research fills a critical gap in that tree nut producers and industry stakeholders need to invest in educational campaigns to limit nut bans, while also investing in new varieties that address consumer concerns about tree nuts.

4:30 PM – 4:45 PM

Responses of Four Ornamental Grasses to Saline Irrigation Water

Alyssa Palmer*[1]; Yuxiang Wang[2] and Youping Sun[1], (1)Department of Plants, Soils, and Climate, Utah State University, (2)Xinjiang Agricultural University

Ornamental grasses are commonly used in urban landscapes in the Intermountain West area of the western United States including Utah. *Eragrostis spectabilis* (purple love grass), *Miscanthus sinensis* 'Gracillimus' (maiden grass), *Panicum virgatum* 'Northwind' (switchgrass), and *Schizachyrium scoparium* (little bluestem) were evaluated in a greenhouse. Plants were watered with a fertilizer solution at an electrical conductivity (EC) of 1.2 dS·m^{-1} (control) or salt solutions at an EC of 5.0 or 10.0 dS·m^{-1} roughly every four days. At harvest (65 days after treatments initiated), *E. spectabilis* and *M. sinensis* had minimal foliar salt damage when irrigated with a salt solution at an EC of 5.0 dS·m^{-1}, while *P. virgatum* and *S. scoparium* exhibited no foliar salt damage. At an EC of 10.0 dS·m^{-1}, *E. spectabilis* and *M. sinensis* displayed slight foliar salt damage with visual scores greater than 3 (0 = dead; 5 = excellent), but *P. virgatum* and *S. scoparium* still had no foliar salt damage. Compared with the control, salt solutions at an EC of 5.0 and 10.0 dS·m^{-1} reduced the shoot dry weight of all ornamental grasses by 25% and 46%, respectively. The leaf sodium concentration of *E. spectabilis*, *M. sinensis*, *P. virgatum*, and *S. scoparium* irrigated with a salt solution at an EC of 10.0 dS·m^{-1} increased by 14.3, 52.6, 5.3, and 1.7 times, respectively, and the chloride concentration increased by 9.4, 11.1, 2.8, and 2.7 times, respectively. All tested ornamental grasses had a very strong salt tolerance. *P. virgatum* and *S. scoparium* could restrict sodium and chloride accumulation in the leaves and were relatively more tolerant to salinity than *E. spectabilis* and *M. sinensis*.

Specified Source(s) of Funding: USDA NIFA Hatch project UTA01381, New Faculty Start-Up Funds from the Office of Research and Graduate Studies, Utah Agricultural Experiment Station, and the Center for Water-Efficient Landscaping at Utah State University

4:45 PM – 5:00 PM

Estimation of Additive and Dominance Effects of a Mutant Glutathione S-Transferase Gene on Anthocyanin and Proanthocyanidin Content in Muscadine Grape (*Vitis rotundifolia*)

Autumn Brown*; Margaret Worthington; Aruna V. Varanasi and Renee T. Threlfall, University of Arkansas

Muscadines are classified as black- or bronze-fruited. The anthocyanin content in the skins of bronze muscadines is usually less than 100 µg.g^{-1}, while the anthocyanin content of black-fruited muscadines ranges from less than 1000 µg.g^{-1} to over 5000 µg.g^{-1}. A glutathione S-transferase gene, *VrunGST4*, has been identified as a candidate gene for berry color in muscadines. A molecular marker was developed within *VrunGST4* to distinguish between muscadine genotypes with bronze (T:T), heterozygote black (C:T), and homozygote black (C:C) berries. The objectives of this study were 1) to determine the correlation between berry skin color and total anthocyanin content, 2) to calculate additive and dominance effects of *VrunGST4* for total anthocyanin content in two biparental F_1 muscadine populations ('Supreme' x 'Nesbitt' and 'Black Beauty' x 'Nesbitt') screened with the intragenic *VrunGST4* marker, and 3) to determine whether *VrunGST4* affects proanthocyanidin content in berry seeds in the biparental F_1 muscadine populations. No correlation was found between hue and lightness of the berry skin and anthocyanin content of black-fruited genotypes in either population. However, there was a slight correlation (r = 0.64) between anthocyanin content and berry skin chroma in the 'Black Beauty' x 'Nesbitt' population. There was no difference in total anthocyanin content of C:C and C:T genotypes in either population, indicating that *VrunGST4* had a completely dominant gene action. The total anthocyanin content of the berry skins from black-fruited genotypes in the 'Black Beauty' x 'Nesbitt' was approximately four times higher than black-fruited genotypes in the 'Supreme' x 'Nesbitt' population. This finding suggested that other genetic loci may contribute to variation in total anthocyanin content in black-fruited muscadines. To investigate the role of *VrunGST4* on proanthocyanidin content in the seeds of muscadine berries, we are measuring total proanthocyanidins in seeds harvested from C:C, C:T, and T:T genotypes in the 'Supreme' x 'Nesbitt' and 'Black Beauty' x 'Nesbitt' populations.

Specified Source(s) of Funding: SURF Undergraduate Research Grant

5:00 PM – 5:15 PM

Initiating a University Vermicompost System: Turning Food Waste into a Horticultural Commodity.

Addison Singleton*[1]; John E. Montoya Jr.[1] and Tina Cade Waliczek[2], (1)Tarleton State University, (2)Texas State Universtiy

Vermicomposting is a process in which red wiggler worms, *Eisenia fetida* Savigny, break down organic material and transform it into vermicompost, a valuable horticultural commodity, while diverting a significant amount of organic matter from the waste stream. College campuses dispose of an estimated 22 million pounds of food per year, material that could be utilized in a vermicomposting system. The purpose of this study was to: 1) establish the vermicomposting system at Tarleton State University using red wiggler worms and cafeteria food waste as a primary feedstock, 2) determine the horticultural and economic potential of using vermicompost in horticultural production courses at the university. Approximately twenty-five pounds of food waste were collected weekly from one cafeteria on campus and combined with shredded university paper waste. A vermicomposting system using a layered bin style was constructed using recycled five-gallon food service buckets from university cafeterias. Worms were checked two to three times weekly and rotated through the system in approximately three to four months. Results demonstrated the value of the operation to the university in terms of the product generated for use in horticultural laboratories, the diverted cost of waste disposal, and the potential to generate revenue from vermicompost.

Plant Nutrient Management 2

Moderator: Jonathan N. Egilla
Lincoln University in Missouri, Jefferson City, MO, USA

4:15 PM – 4:30 PM

Nutrient Ion Balancing for Hydroponic Solutions According to Raw Water Analysis

Chiwon W. Lee*, North Dakota State University

Preparation of nutrient solutions for hydroponic culture is often challenging especially when the raw water quality is suboptimal. The universal use of preformulated commercial fertilizers for hydroponic solutions may be undesirable when raw water contains high levels of minerals. If the raw water contains high concentrations of salts which are non-essential plant nutrients such as Na^+ and Cl^-, macronutrients added to the nutrient solution must be adjusted to counteract the detrimental influence of excess salts. To prepare a commonly used standard hydroponic solution containing (in meq/L) of 3 Ca^{2+}, 2 Mg^{2+}, 6 K^+, 2 NH_4^+, 10 NO_3^-, 2 SO_4^{2-}, and 1 $H_2PO_4^-$ is simple if raw water contains no or low levels of minerals. The amount of macronutrients added to the nutrient solution being prepared has to be adjusted to accommodate the levels of each of the cations and anions already present in the raw water. The pH, mineral contents, and alkalinity of raw water, especially ground water, vary greatly by geographic regions. A simple system of balancing the cationic and anionic macronutrients and pH adjustment for optimum hydroponic solution according to water analysis will be presented.

Specified Source(s) of Funding: ND Department of Agriculture Specialty Crop Block Grant

4:30 PM – 4:45 PM

Nutrient Element Interactions with Leaf Growth of Collards in Response to Hydroponic Solution Composition

Jonathan N. Egilla*, Lincoln University in Missouri and Isabelle Nyirakabibi, Lincoln University of Missouri

Compound fertilizers with high N, P or K analysis, and optimum levels of micronutrients contain inadequate concentrations of the latter for optimum plant growth when diluted for use as hydroponic nutrient solution. This study compares the effect of hydroponic nutrient solution composition on foliar nutrient interactions and growth (leaf dry weight [LDW] per plant) of collards (*Brassica oleraceae* L. Acephala Group). Seedlings were grown with either arGrow Complete™ Spruce commercial fertilizer (70% Arginine-nitrogen; SweTree Technologies AB, Sweden) at 200 mg N/liter or full-strength Steiner's solution (Steiner's) in hydroponic culture (pH 6.5 – 7.2). Fertilizer treatment (FERT) comprised of arGrow at micronutrient concentration proportional to that supplied at 200 mg N/liter (low; ($arG_{[LM]}$) or equivalent to full-strength Hoagland's solution (optimum; $arG_{[OM]}$). No significant (p = 0.05) differences in leaf growth of collards between $arG_{[LM]}$ and $arG_{[OM]}$. Steiner's increased LDW significantly ($p < 0.05$) compared with $arG_{[OM]}$, but not $arG_{[LM]}$. With the exception of K (Steiner's > $arG_{[LM]}$, $p = 0.0201$), FERT had no significant ($p = 0.05$) effect on foliar N, P, Ca, Mg and S. Increases in foliar Mn, Zn, Cu, B and Mo content at $arG_{[OM]}$ compared with $arG_{[LM]}$ were significant ($p < 0.05$). Vector analysis helped in assessing the interactions between foliar nutrient elements and growth. It compared the indices: relative LDW (*W*), nutrient concentration (*A*) and nutrient content (*C*) in a single nomogram, in which indices of the reference treatment ($arG_{[LM]}$) were normalized to 100. Despite lack of significant ($p = 0.05$) FERT effect, depressed *W* with $arG_{[OM]}$ caused higher K, N, and moderate Ca, Mg and S accumulation compared to $arG_{[LM]}$, consistent with a concentration effect. Leaf *W*, *A* and *C* of phosphorus decreased by 9%, 12 % and 20%, respectively, indicating antagonism, possibly by the observed excess accumulation of Zn and Mn, with *A* of 94% and 96%, and *C* of 76% and 36%, respectively. High Zn and Mn, but moderate B, Cu and Mo accumulation occurred with $arG_{[OM]}$ compared to $arG_{[LM]}$. Steiner's (+35% W over $arG_{[OM]}$), enhanced the uptake of foliar deficient K, N, and Ca, in contrast to growth induced dilution of P, S and Mg. Compared with $arG_{[LM]}$, foliar deficiency of Zn, Fe and Mo in Steiner's induced tissue accumulation; while Cu uptake reached steady state *A* and was non-limiting to growth.

Specified Source(s) of Funding: This work was funded by USDA-NIFA Grants: MOLU-HYDROPONICS-05 awarded to Lincoln University of Missouri.

4:45 PM – 5:00 PM

Development of N-Fertilizer Management for Cabbage Production in Southeast US

Andre Luiz B.R. da Silva*[1]; Joara S. Candian[1]; Timothy W. Coolong[1]; Lincoln Zotarelli[2] and Christian T. Christensen[2], (1)University of Georgia, (2)University of Florida

Florida and Georgia are major cabbage production states in the United States. In both states, cabbage growers have challenges with soil nitrogen (N) leaching caused by coarse textured soils and heavy rainfall events. Consequently, N-fertilizer is applied in high rates to ensure yield. The objective of the study was to identify the N-fertilizer management that mitigate N-fertilizer rates without impact cabbage yield. Field experiments were conducted in Hastings, FL, during 2016 and 2017 cabbage seasons, and in Tifton, GA, during the 2018 cabbage season. Cabbage plants were grown at 8-in and 12-in in-row spacing in Florida and Georgia, respectively. In both locations, treatments were a two factorial of N-fertilizer rate (175, 225, and 280 lbs./ac) and cabbage variety (Bravo, Cheers, Capture, Bronco, Ramada, and Bruno) randomized in a complete block design (r = 4). At harvest, cabbage total and marketable yield was measured. Regardless of variety, the application of 170 lbs./ac of N had no significant difference in total yield compared to 225 and 280 lbs./ac in Florida for 2016, when rainfall accumulation was 10.5 in. Average total yield among N-fertilizer treatments in 2016 was 45,391 lbs./ac, while the variety Cheers had the highest total yield (48,410 lbs./ac) and Capture the lowest total yield (43,660 lbs./ac). In 2017, there was an interaction between N-fertilizer rates and varieties in Florida. The application of 175 lbs./ac sustained yield for Capture and Ramada which averaged 50,715 and 50,217 lbs./ac, respectively. The varieties Cheers, Bronco and Bruno required a minimum of 225 lbs./ac to increase total yield, and averaged 59,730, 43,062, and 54,801 lbs./ac, respectively. While, Bravo required 280 lbs./ac to achieve the highest yield (54,751 lbs./ac). Rainfall accumulation in Florida cabbage season of 2017 was 2.1 in. In Georgia, there was no significant difference among N-fertilizer rates, regardless of variety. The N-fertilizer rate of 175 lbs./ac was sufficient to sustain total yield (38,206 lbs./ac) when rainfall accumulation was 22.3 in. Regarding variety, total yield was the highest for Bronco (45,299 lbs./ac) and lowest for Capture (30,880 lbs./ac) in Georgia. Overall, marketable yield represented 27% and 8% of total yield in Florida and Georgia, respectively. The effect of N-fertilizer rates on marketable yield was similar to those measured in total yield. Thus, the N-fertilizer rate of 175 lbs./ac sustained cabbage yield but still a proper N-fertilizer management should consider rainfall distribution to ensure soil N leaching is not reducing cabbage yield.

5:00 PM – 5:15 PM

Influence of Integrated Nutrient Management on Nitrogen Availability and Organic Strawberry Production

Jianyu Li*; Xin Zhao; Gabriel Maltais-Landry; Bodh R. Paudel and Zack Black, University of Florida

Strawberries are among the top selling organic commodity in the U.S. and are undergoing an increase in organic acreage recently. In Florida, the second leading state in organic strawberry production, organic nutrient management is complex due to sandy soils with poor water and nutrient retention capacity and a warm and moist subtropical climate. The objective of this study was to assess the influence of integrated nutrient management practices and their synergistic effects on N availability and uptake, plant growth, and yield in organic strawberry production systems. The field trial was conducted on certified organic land at the University of Florida Plant Science Research and Education Unit in Citra, FL, using Sweet Sensation® 'Florida127'. A split plot design with 4 replications was used, and the main plots consisted of combinations of cover crop (sunn hemp or fallow) and compost (no compost, 22.4 t ha^{-1} or 44.8 t ha^{-1}) treatments. The compost was a mixture of 50% food waste compost and 50% yard waste compost based on volume. The subplots consisted of organic fertilization treatments: no fertilizer control, preplant fertilizer (84.1 kg N ha^{-1}), in-season fertigation (328.7 kg N ha^{-1}), and a combination of both. Sunn hemp (*Crotalaria juncea* L.) was seeded at 44.9 kg/

ha in July 2017 then flail-chopped and incorporated into the soil 64 days after seeding. The strawberry was transplanted in Oct. 2017 and the final harvest occurred in Apr. 2018. Sunn hemp residue incorporation increased soil NO_3-N availability before strawberry bed formation and marketable fruit yield during the early season. Compost increased soil pH and CEC, at the end of strawberry season but did not significantly affect fruit yield. Marketable fruit yield did not differ significantly between preplant fertilization and in-season fertigation during the early and mid season, while the combined fertilization treatment consistently produced the highest yield from Dec. to Feb. Total marketable yield was significantly higher in the fertigation and combined fertilization treatments compared with preplant fertilization. The combined fertilization treatments resulted in the highest total fruit yield for the whole season; in addition, the total fruit yield was significantly higher in the fertigation treatment versus the preplant fertilization treatment. Overall, the early release of N from sunn hemp residues, lack of response to compost and benefits of fertigation highlight the challenges of optimizing N availability in organic strawberry production to maximize yields while minimizing N losses.

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Specified Source(s) of Funding: USDA OREI

5:15 PM – 5:30 PM

The Effects of Compost Addition to Agricultural Green Roofs on Runoff Water Quality.

Leigh Whittinghill*, Kentucky State University

Space availability is one of the largest barriers to urban agriculture. One way around this issue that urban farmers in some parts of the world are exploring is moving their farming activities to building rooftops. One method of rooftop farming in use is row agriculture using green roof technology. This often comes with some challenges, as green roof media is typically fast draining and contains limited nutrients. Vegetable crop plants, which typically require more water and more nutrients that the ornamental species typically found on green roofs require irrigation and the use of fertilizers. One nutrient management practice that some rooftop farmers are using is the addition of compost, which could lead to changes over time in the water holding capacity, organic matter content, and weight of green roof media. This practices and its long term implications have not been well studied. Green roof platforms were set up at the Harold R Benson Research and Demonstration Farm to examine how addition of compost effects runoff water quality and green roof media properties. Compost treatments included a no compost control, and the addition of 0.33, 0.66 and 1 kg/m^2 of compost. Organic fertilizers were used to supply additional nutritional needs to vegetable plants grown in the green roof platforms. All green roof platforms are fitted with gutters and water collections buckets. Water samples were collected every month starting July 2018, weather permitting. Water samples were then analyzed for pH, conductivity, color, turbidity, and nitrate-nitrogen, ammonia-nitrogen, total phosphorus, and potassium content. Water quality results were analyzed in R. Analysis of Variance was performed on all variables with compost treatment and month of sampling as fixed effects. Significant differences between treatment means were analyzed using Tukey HSD with an alpha of 0.05. Preliminary results from 2018 do not show a significant effect of compost treatment on water quality metrics within the green roof platforms. There are however some differences between the green roof platforms and similar platforms filled with topsoil that were managed the same way the no compost controls were in this study. There is however a significant effect of sampling month on some runoff water quality metrics. Runoff water pH, conductivity, color and ammonia-nitrate concentration decrease with time. Nitrate-nitrogen and potassium concentrations were higher lowest in July at the start of the study an in November. Total phosphorus concentrations appear to be decreasing with time.

Specified Source(s) of Funding: National Institute of Food and Agriculture Evans Allen Project (KYX-10-17-64P)

Herbs, Spices, & Medicinal Plants 2

Moderator: Ariane Vasilatis
Rutgers University, New Brunswick, NJ, USA

4:15 PM – 4:30 PM

Organic and Inorganic Fertilization in Mint: Quality and Yield of Biomass and Essential Oil

Maria T. Colinas-Leon*, Autonomous University of Chapingo; Laura Pichardo-Rosiles Laura, Entidad Mexicana de Acreditación, A.C.; R.. Marcos Soto-Hernandez Sr., Colegio de Postgraduados. and Joel Pineda-Pineda Sr., Universidad Autonoma Chapingo

The mint is economically important for its fresh and dry leaves and its essential oil. Little is known about mint production with organic substrates and how growth and development indicators change. This is important, due to its great marketing potential in the food, pharmaceutical and cosmetic markets, and mainly for the characteristics that the market demands from it. Mint plants were grown under greenhouse conditions, four organic fertilizers were evaluated, namely Vermicompost, Compost, Biovital® and Worm Leachate, plus a chemical fertilizer, Steiner Nutrient Solution. Production and quality of biomass and essential oil was considered. Leaves were harvested 120 days after transplanting, when the first flowers were observed. The Steiner solution was the best fertilization in terms of showing the highest biomass yield. Regarding the organic fertilizers, Biovital® was the best treatment for biomass yield variables. The best treatments for essential oil content were the Steiner Nutrient Solution and Worm Leachate. The treatment with the lowest chlorophyll accumulation was the one using Biovital®.
On the other hand, chlorophyll content and SPAD units,

showed a high correlation (R^2=0.94). Finally, the fertilization sources used in this experiment had no significant effect on the composition of the essential oil. The GC-MS analysis showed myrcene (Rt9.02), eucalyptol (Rt 10.09), limonene (Rt 10.11), linalool (Rt12.18), menthone (Rt 14.08), piperitone oxide (Rt 16.65) and chavibetol (Rt19.23), which were identified as function of retention time (Rt) and according to the Spectra Library NIST V. 2008. These compounds were in very low concentrations in all the treatments, so they were not analyzed statistically. No menthol content was detected, probably due to its degradation during oil isolation, or the moment of taking the leaf samples.

Key words: *Mentha piperita*, vermicompost, compost, worm leachate, SPAD units.

Specified Source(s) of Funding: University of Chapingo. Institute of Horticulture

4:30 PM – 4:45 PM

Codonopsis Root Production and Polysaccharide Content in Central Washington State

Xiaozhong Liu*[1]; Franklin Johnson[2]; Xun Yan[1] and Teric Li[3], (1)Amway Corporation, (2)Trout Lake Farm, (3)Amway Botanical Research Center

Codonopsis root is a Traditional Chinese Medicine (TCM) used as a mild version of ginseng. Many species are present in the codonopsis genus, but Chinese Pharmacopeia only allowed three species to be claimed as TCM: *Codonopsis pilosula* (Franch.) Nannf, *Codonopsis pilosula* Nannf. Var. Modesta (Nannf.) L.T.Shen and *Codonopsis tangshen* Olive. In 2017, and 2018, we examined the feasibility to grow these three codonopsis species in Trout Lake Farm (TLF), an Amway owned organic farm located in central Washington State. We sourced one variety for each species from China: Baidang (*Codonopsis pilosula* (Franch.) Nannf), Wendang (*Codonopsis pilosula* Nannf. Var. Modesta (Nannf.) L.T.Shen) and Bandang (*Codonopsis tangshen* Olive). Seeds were directly sown in the field in May 2017 and managed with typical Washington State crop management practices. Roots of each variety were harvested half at the end of growing season of 2017 and 2018, respectively. Results indicated that root production and total polysaccharide contents were similar among the three tested varieties. Root polysaccharide contents from TLF were higher than those purchased from commercial available product. We also investigated Baidang root production and polysaccharide content in response to organic nitrogen fertilizer rates in 2017 and 2018. In this study, Baidang seeds were germinated in 231-cell trays filled with potting mix, grown in the greenhouse for 2 months and transplanted into the field. Results indicated that N fertilizer increased Baidang root production and polysaccharide content. The optimum fertilizer rate for Baidang root production was 24.2 g N M-2 which equivalent to 216 lbs. N Ac-1. The optimum fertilizer rate for polysaccharide content was 16.1 g N M-2 which is equivalent to 144 lbs. N Ac-1. Results suggested *Codonopsis pilosula* (Franch.) Nannf has the potential to be grown in USA.

Key words: *Codonopsis pilosula* (Franch.) Nannf, *Codonopsis pilosula* Nannf. Var. Modesta (Nannf.) L.T.Shen, *Codonopsis tangshen* Olive, Traditional Chinese Medicine, root production, total polysaccharide content

4:45 PM – 5:00 PM

Hop Variety Trials Under Extended Day Length in Central Florida

Zhanao Deng*[1]; Shinsuke Agehara[1]; Gary E. Vallad[1]; Hugh A. Smith[1]; Johan Desaeger[1] and Simon Bollin[2], (1)University of Florida, (2)Hillsborough County Economic Development

Hops are an essential ingredient of beer. The burgeoning craft brewery industry in Florida has created a significant demand for locally produced hops, which coincides with Florida growers' need of alternative specialty crops. An experimental hop yard with a typical high trellis was installed in central Florida in spring 2016. Hop plants grown in 2016 and 2017 under natural Florida day lengths (ca. 12 to 14 hours from March to September) were short and thin, with few laterals, and had very low yields of hop cones (below 868 lbs of fresh hops per acre). In 2018, the day length was extended by approximately 5 hours using supplemental LED lighting until plants reached a height of approximately 19 ft and developed multiple lateral bines. Under the extended day length, two crops were harvested in 2018, with the first one in mid June and the second crop in mid December. Fourteen commercial hop varieties evaluated under this system showed remarkable differences in plant growth, lateral development, cone yield, and chemical qualities. 'Cascade' and 'Galena' had the highest hop cone yields (2800 to 3715 lbs of fresh hops, or 620 to 987 lbs of dry hops, per acre per year), followed by 'Comet', 'Magnum', 'Nugget', 'Willamette' and 'Zeus' (1285 to 1752 lbs of fresh hops, or 300 to 500 lbs of dry hops, per acre per year). Hop cones were analyzed for alpha acid content, beta acid content, oil content, etc. Local craft brewers produced desired beers using the produced hop cones in small-scale test brewing.

Specified Source(s) of Funding: USDA and FDACS Specialty Crop Block Grant Program projects (15SCBGPFL0038; USDA-AMS-SCBGP-2017/FDACS Contract #024853).

5:00 PM – 5:15 PM

Breeding for Aroma Using Sensory Analysis to Generate an Array of Sweet Basils in Search of That Perfect Bouquet

Ariane Vasilatis*; Regina O'Brien; Beverly J. Tepper; Rodolfo Juliani; Thomas Gianfagna and James Simon, Rutgers University

Basil (*Ocimum basilicum)* is the most poplar aromatic culinary herb in the USA and one of the most around the world. Basil is found in cuisine all over the world being

used as a garnish, condiment, flavor, or an aroma and flavor ingredient. With the development of new and increasingly aggressive pathogens such as downy mildew, breeders are faced with the task of developing resistant lines as well as focusing on ensuring high yields, and excellent disease resistance. With aromatic plants, selecting and breeding for aroma is important to ensure new and improved varieties meet the market and consumer preferences relative to aroma considerations. In this study, we identify the major chemical components and proportions of basil and their contribution to the overall aroma. In addition, we use chemical sensory response in concert with chemical analysis, using GCMS-SPME, to bridge the gap between aroma composition of different sweet basils and consumer perception. The results of this study provide new innovative ways to link breeding and consumer feedback to better understand and define the perfect basil bouquet.

Specified Source(s) of Funding: United States Department of Agriculture and New Jersey Agricultural Experiment Station

5:15 PM – 5:30 PM

Phenolic Content and Anti-Oxidation Properties of Ginger Is Influenced By Harvest Time: An Effective Medicinal Produce for Preventing Obesity

Rafat Siddiqui*; Haiwen Li; Anwar Hamama; Toktam Taghavi and Reza Rafie, Virginia State University

Ginger (*Zingiber officinale*) is a new emerging niche crop for small farmers in Virginia. Currently, locally grown ginger is not fully mature, and is marketed under 'Baby ginger.' Immature baby ginger is more perishable, less fibrous, and pungent when compared to fully mature imported products. It is also not known if phytochemical profile and health benefits of the "immature" ginger are different to "fully mature" produce. We conducted research to determine the phenolic content, and anti-oxidation properties of ginger at different harvesting times and to test its effects on obesity. Ginger samples at different stages of maturity were harvested every two weeks starting from October 15, 2017 until January 15, 2018. Our data indicate that ginger has the highest content of phenolic compounds and superior anti-oxidation activity when harvested early (immature baby ginger); however, the concentration of phenolic compounds and its anti-oxidation activity were progressively reduced up to 50% as ginger matured. Furthermore, the data indicate that ginger was able to reduce oil droplet accumulation by 25%-40% in 3T3-L1 adipocytes in a dose dependent manner, possibly via inhibition of de novo fatty acid synthesis. The effects of ginger on fat synthesis appear to be mediated through down-regulating PPAR-gamma and CEBP-beta gene expression. Our results suggest harvesting of ginger at appropriate (early) time to optimize or maintain the qualitative and quantitative levels of biological active compounds. The data also suggest that a regular use of ginger can potentially impact on lowering incidences of obesity and obesity-related complications, a growing concern in the state of Virginia. Furthermore, increase ginger consumption will help to develop local and regional farm economy.

Specified Source(s) of Funding: CAREO

5:30 PM – 5:45 PM

Evaluate *Camellia sinensis* Germplasm to Select Superior Varieties for Mississippi

Qianwen Zhang*; Guihong Bi; Judson S. LeCompte; Tongyin Li and Richard L. Harkess, Mississippi State University

Tea is the most popular beverage in the world. US market demands for tea increased from $1.8 billion in 1990 to over $12 billion in 2018, which were met almost exclusively by importation. In recent years, there has been increasing interest in domestic tea production. The subtropical climate in Mississippi is suitable for growing tea. The objective of this study was to evaluate plant growth performance and identify suitable varieties to be grown in MS. Ten tea varieties were evaluated in this study: BL1, BL2, Black Sea, Christina's Choice, Dave's Fave, Large leaf, Small leaf, Sochi, var. *assamica*, and var. *quinquibracteata*. Plant growth index (PGI), leaf size, cold tolerance, and photosynthesis data were collected. For two-consecutive years, BL2 had the highest PGI. Black Sea and Large leaf had lower PGI than BL2 but higher than other varieties. Different tea varieties showed various cold tolerance when the winter temperature reached -14°C in Jan. 2018. Two varieties var. *quinquibracteata* and Christina's Choice were most severely damaged. Small leaf, BL2 and Sochi had very minor cold damage. The variety Large leaf had similar leaf size in terms of average single leaf area (29.4cm^2) as Dave's Fave (26.1cm^2), but significantly larger leaf size than the other eight varieties, with BL1 having the smallest leaves (13.1cm^2). There was no significant difference in plant photosynthetic activities.

5:45 PM – 6:00 PM

Cold Stratification and Removal of Pericarps for Breaking Dormancy and Improving Germination Rate of Coastal Glehnia

Moon-Sun Yeom*; Nguyen Thi Kim Loan and Myung-Min Oh, Chungbuk National University, Brain Korea 21 Center for Bio-Resource Development

A traditional medicinal plant, coastal glehnia (*Glehnia littoralis* Fr. Schmidt ex Miquel) is a valuable perennial herb, distributed on the east and west coasts of South Korea. It belongs to the Umbelliferae, which have been known to have a morpho-physiological dormancy (MPD). In this study, we aimed to find conditions for breaking dormancy and increasing the germination rate of coastal glehnia. Cold and/or warm stratifications (5°C or 25°C for 8 weeks, 5°C and 25°C for 4 weeks each) were used to break dormancy in growth chambers. For wet cold treatment, the seeds were stored at 5°C with wet gauze for 8 or 10 weeks. After then, the pericarps of cold-treated seeds for 10 weeks were removed and placed on petri dishes, which were incubated in growth chambers with five different constant air temperatures (5, 10, 15, 20, and 25°C) for 25 days. To examine the germination inhibitory effect of pericarps, the extracts of seeds with pericarps, seeds and pericarps were treated on lettuce seeds and the seed germination rate was investigated for 7 days. The cold stratification (5°C) for 8 weeks showed 11% of germination rate but the other stratifications had the germination rate of less than 2%. The ratio of embryo to seed was 1.6 times higher than that of dry seeds at 8 weeks of wet cold treatment. Removal of pericarps increased the germination rate; the final germination rate under 15°C and 20°C were 68% and 65%, respectively. The mean germination time (MGT) and time to reach 50% of germination (T_{50}) were significantly the shortest at 20°C among the treatments. Extracts of pericarps were ineffective to inhibit germination rate of lettuce seeds suggesting the absence of germination-inhibiting compounds in the pericarps. These results concluded that seeds of coastal glehnia have a MPD and wet cold treatment for 8 weeks and removal of pericarps before germination under 15°C or 20°C are required to break dormancy and increase germination rate of coastal glehnia.

Specified Source(s) of Funding: This work was carried out with the support of "Cooperative Research Program for Agriculture Science and Technology Development (PJ.013852012019)" Rural Development Administration, Republic of Korea.

Wednesday, July 24, 2019

Ornamental Plant Breeding 1

Moderator: Krishna Bhattarai
Gulf Coast Research and Education Center, University of Florida, Wimauma, FL, USA

8:00 AM – 8:15 AM

Flower Form and Ploidy Affect Female Fertility in Althea

Ryan N. Contreras*, Oregon State University and Jason Lattier, High Point University

Althea (*Hibiscus syriacus*) is a hardy shrub valued for its showy summer flowers and adaptability. Flowers include an array of colors and also may be single, semi-double, or double. Its naturally occurring cytotype is tetraploid ($2n = 4x = 80$) but breeders have developed higher ploidy plants to reduce fertility. Both flower form and ploidy have been shown to impact fertility, but quantification remains incomplete. The objectives of this study were to 1) quantify female fertility of $4x$, $5x$, and $6x$ genotypes and 2) quantify female fertility of single, semi-double, and double flowers. Each taxon from these representative groups were pollinated with a variety of male-fertile genotypes. Single and semi-double flowers did not differ in female fertility (9.7 and 10.0 seeds per pollination) but double flowers had only 2.2 seeds per pollination. Pollinating tetraploids yielded an average of eight seeds per pollination and ranged from zero to 32 seeds per pollination. Taxa with genome sizes in the range of pentaploid (5.7 to 6.8 pg) had an average of three seeds per pollination. However, there were four outliers that stood out in the data and after removing these accessions there was 0.9 seeds per pollination. The lowest fertility was observed among the three cytotypes was for hexaploid taxa, with only 0.05 seeds per pollination after making 402 pollinations. It is unclear why the pentaploid taxa were more female fertile compared to hexaploids in this study, but several points are worth noting. First, there was a high degree of variability in female fertility among tetraploid taxa that were expected to be fully fertile, suggesting greater complexity in the regulation of fertility – possibly involving inbreeding depression during cultivar development. Second, hexaploids plants likely produce more multivalents that result in improper disjunction during gamete formation. Relatedly, the so-called pentaploids may actually be aneuploids that lose extra chromosomes during gamete formation and result in euploid gametes (e.g. $n = 2x = 40$) during egg formation. Finally, using hexaploids as female in crosses with tetraploid males represents further deviation from standard maternal:paternal contribution (2:1). Specifically, the theoretical maternal: paternal contribution of $6x$ x $4x$ crosses is 3:1, while that of $5x$ x $4x$ crosses is 2.5:1. To draw conclusions genome size analysis of all interploid progeny as well as cytological analysis of $5x$ and $6x$ plants is necessary.

Specified Source(s) of Funding: Oregon Department of Agriculture and HATCH funds.

8:15 AM – 8:30 AM

Ploidy Levels in the Abelia Genus

Leynar Leyton Naranjo*, University of Georgia and Carol D. Robacker, University of Georgia, Georgia Campus

Abelia is a genus of flowering woody shrubs with high ornamental and landscape potential. Only a few species and cultivars are available commercially and these are mostly sports of *Abelia* x*grandiflora*. Despite the diversity of the genus and its 174 years of use as an ornamental plant, no genetic information is available and ploidy levels are unknown. Genome sizes were estimated in a CyFlow © Ploidy Analyser (Sysmex ™) with propidium iodide as a stain, using *Raphanus sativus* 'Saxa' and *Abelia* x*grandiflora* (2n=32) as internal standards. Genome sizes were estimated in the species *Abelia chinensis* (three accessions), *Abelia engleriana*, *Abelia floribunda*, *Abelia* x*grandiflora*, *Abelia schumanii* and *Abelia serrata*, the hybrids 99-1-1 (*A. chinensis* x *A.* 'Edward Goucher'), 99-6-7 (*A.* 'Edward Goucher' x *A. chinensis*), and 99-6-11 (*A.* 'Edward Goucher' x *A. chinensis*), and the cultivars *A.* 'Edward Goucher' (*A. chinensis* x *A. schumannii*), *A.* 'Francis Mason' (sport of *A.* x*grandiflora*) and *A.* 'Raspberry Profusion' (*A.* 'Edward Goucher' x *A. chinensis*). *Abelia engleriana*, *A.* 'Edward Goucher', *A. schumannii, Abelia* x*grandiflora*, *A. serrata*, *A.* 'Francis Mason', two accessions of *A. chinensis, A.* 'Raspberry Profusion', and the hybrids 99-1-1, 99-6-7, and 99-6-

11, have a genome size of approximately 0.89 to 0.93 pg of DNA. One accession of *A. chinensis* presented inconclusive results. *Abelia floribunda* has a genome size two times larger, approximately 1.92 pg of DNA, and stomata statistically larger the other Abelia species used in this study, suggesting a ploidy level greater than the other species of the study.

8:30 AM – 8:45 AM

Battling Rose Rosette Disease in the Great Plains

Michael A. Schnelle*[1]; Jennifer D Olson[1]; Jason J. Griffin[2] and Lynda Carrier[3], (1)Oklahoma State University, (2)Kansas State University, (3)oklahoma state university

Rose rosette disease (RRD) was first reported in the United States in 1940. Since then, the disease has become widespread east of the Rocky Mountains particularly with the advent of free-blooming cultivars that landscapers utilize in virtually every project. Even though the causal agent was identified in 2011 and a better understanding now exists of the eriophyid mite that transmits the rose rosette virus, RRD is still rampant and thus responsible for thousands of dollars in losses to producers, landscapers and ultimately, end consumers. The disease is readily spread through movement of the mite by crawling, wind, or through human-induced physical movement of the mite. Consequently, rose trials were initiated at Oklahoma State University and Kansas State University in 2016. Researchers have since found commercially available rose cultivars that possess RRD resistance. These selections will be presented to rose breeders for consideration in future breeding programs. In addition to cultivar trials, best management practices are being studied in order to slow progression of this disease.

8:45 AM – 9:00 AM

Identification and Characterization of Disease Resistance and Susceptibility Genes in Gerbera Leaf Transcriptomes

Krishna Bhattarai*, Gulf Coast Research and Education Center, University of Florida and Zhanao Deng, University of Florida

Gerbera daisy is one of the most popular flowers in the worldwide floricultural trade. Multiple fungal diseases can blight gerbera plants and flowers in natural and controlled environments, causing severe economic losses. Despite this, limited information on disease resistance in gerbera is known so far. In this study, we sequenced the leaf transcriptomes of two gerbera lines with contrasting traits for flower color, peduncle length, flower form and powdery mildew resistance. Transcriptome assembly using Trinity, Trans-Abyss, Velvet and Soapdenovo resulted in 145,348 contigs with an N50 of 1124 nucleotides and a mean contig length of 761 nucleotides. A total of 67,312 contigs contain open reading frames. Functional annotation of these contigs using Blast2Go identified 494 genes involved in disease resistance, including 382 genes containing the nucleotide-binding site (NBS) domain that is present in many cloned plant disease resistance genes. Among these NBS genes, 69 belong to the recognition of *Peronospora parasitica* (*RPP*) gene family. There were 306 genes containing the coiled-coil (CC) domain and 31 genes containing the Toll-like receptors (TIR) domain. Fifteen susceptibility genes were identified, belonging to the *mildew resistance locus o (MLO)* or the *Long Vegetative Phase 1* (*LOV1*) gene family. Genes identified from this study may serves as candidate genes for over-expression to increase disease resistance in gerbera. The *MLO* and *LOV1*-like genes may be potential targets for CRISPR-mediated genome editing and gene knocking out to enhance disease resistance in gerbera.

9:00 AM – 9:15 AM

Cobalt-60 Irradiation Influences Germination of Three *Pavonia* Species

Yongjun Yue* and John M. Ruter, University of Georgia

Irradiation generates random variation, resulting in mutant plants with new morphological traits. Preliminary research in our lab on *Pavonia hastata* showed a curvilinear response of seed germination to radiation dosages between 0 to 800 Gy. Since *P. hastata* can tolerant high rates of irradiation, a study was initiated with three species of *Pavonia* (*P. hastata, P. lasiopetala,* and *P. missionum*) treated at Cobalt-60 irradiation at rates of 0 Gy, 200 Gy, 400 Gy, 600 Gy, 800 Gy, and 1,000 Gy. Four replicates for each treatment and 50 seeds for each replicate were planted. Similar to many genera in the Malvaceae, the genus *Pavonia* has impervious mericarps which inhibit the uptake of water. Scarification with concentrated sulfuric acid was applied for 10 min on seed of all three species to break the physical dormancy caused by the mericarp. The effect of scarification was observed using Scanning Electron Microscopy (SEM). A preliminary study in 2018 indicated that seed germination of *P. hastata* showed responded linearly to radiation dosages from 0 to 1,000 Gy. The control (0 Gy) had highest germination percentage (58%) after 31 days whereas germination at 1,000 Gy was 34%. Germination percentages were randomly distributed for *P. lasiopetala* with the highest germination percentage (85%) occurring at the 800 Gy treatment. *P. missionum* was the most vigorous among the three species with over 90% germination for four irradiation levels (0 Gy, 200 Gy, 400 Gy, and 800 Gy) and over 60 % germination for two irradiation levels (600 Gy and 1,000 Gy). Interestingly, 64% germination was observed for *P. missionum* at the 1,000 Gy treatment, but the seedlings remained at the cotyledon stage until the end of the study. Only three seedlings at 1,000 Gy survived after three months. Irradiated plants were transplanted to 2.8 l pots and grown for further evaluation. Seed from the irradiated plants (M1 – first mutant generation) were collected and will be grown in 2019 since mutations are usually seen in M2 generation. The seed germination study will be repeated in 2019.

Tree Fruits

Moderator: Will Wheeler
Utah State University, Logan, UT, USA

8:00 AM – 8:15 AM

Determination of Tree Water Status Based on the Ratio of Relative Sap Velocity Measurements to Modeled Evaporative Demand

Will Wheeler* and Bruce Bugbee, Utah State University

Deficit irrigation has been shown to offer a number of benefits for tree fruit production and orchard upkeep. To most effectively implement this strategy, accurate real-time assessment of tree hydration is necessary to prevent crop losses while maximizing benefits. Sap flow sensors have been used extensively to estimate transpiration, but accurate calibration can be challenging, requiring large amounts of time and expertise. The use of these sensors for determination of sap velocity, however can be easily implemented. Sap velocity has been shown to be well correlated with evaporative demand. Short reference Penman-Monteith is widely reported and utilized with crop coefficients for irrigation scheduling but is not sensitive enough for precision irrigation scheduling alone. We propose an index of tree hydration for use in deficit irrigation scheduling using a ratio of sap velocity measurements to modeled evaporative demand. Initial comparisons of sap velocity measurements to short reference Penman-Monteith modeled evapotranspiration under sunny conditions were highly correlated (r^2 = 0.95) on an hourly basis and well correlated when integrated into a daily time interval (r^2 = 0.71). Under these conditions the proposed index deviated from average by roughly 4% in a well-watered tree. However, modeled evapotranspiration declined faster in relation to measured sap velocity during days with high cloud cover, causing the index to spike. Estimates of evapotranspiration based on short reference Penman-Monteith are highly sensitive to net incoming radiation, while transpiration in tall discontinuous canopies has been reported to be strongly coupled with bulk air parameters. Further studies are needed to determine whether this limitation in the model will affect the viability of the proposed index for deficit irrigation scheduling.

Specified Source(s) of Funding: Utah Water Initiative grant program

8:15 AM – 8:30 AM

Developing Strategies for Mitigating the Impacts of Freezing on Olive Production in Texas

Amit Kumar Mishra*; Qiushuo Song; Seth Andres; Madhumita Joshi and Vijay Joshi, Texas A&M AgriLife Research

Olive (*Olea europaea* L.) orchards in Texas now represent the fifth highest acreage among fruit crops. However, occasional freezing events forces the trees through cycles of the acclimation-de-acclimation process damaging the orchards, especially young plants. This damage often results in severe losses in yield, oil quality, and even tree death. Most of the varieties currently used for olive production in Texas are not well adapted to survive under freezing stress. Cultivar 'Arbequina' dominates over 80% of the production in Texas risking the dangers of exposing monoculture genetic background to various abiotic and biotic stresses. As a step toward developing varieties adapted to the Texan climate, we evaluated the mechanism of freezing tolerance using regionally adapted varieties at four different locations. Our preliminary analysis of vegetative tissue of ten varieties grown at various orchards (Carrizo Springs, Georgetown, Dripping Springs, Moulton) indicated significant genotypic variation among primary metabolites. The differences in the N-rich amino acids are critical to the freeze tolerance response as well as nitrogen assimilation and mobilization during the development. The variety 'Picual' accumulated significantly higher total amino acids and N-rich amino acids (Glutamate, Glutamine, and Alanine) in leaves than the regionally popular variety; Arbequina. Identification of potential biochemical marker(s) and determination of their functional role will help in understanding the molecular mechanisms involved in freeze tolerance in olives. We are evaluating the impacts of a probiotic - Lalitha-21 (Acela BIOTEK) on the productivity and freezing tolerance of olive plants in Texas. This study will help in determining the effect of probiotics on the nutritional makeup of the plants, soil nitrogen availability and solubilization of minerals to develop long term nutrient management strategy.

Specified Source(s) of Funding: Specialty Crop Block Grant Program, Texas Department of Horticulture

8:30 AM – 8:45 AM

Olive Mill By-Products for Control of *Verticillium Dahliae*

Leigh F Archer*[1]; Dean Watson[2]; Tom Gordon[2]; Louise Ferguson[1] and Amanda Hodson[2], (1)University of California, Davis, (2)UC Davis

The soil borne fungal pathogen, *Verticillium dahliae,* can remain viable in soil for more than ten years until germination is precipitated by the presence of roots. Previous studies suggest that raw olive pomace and olive pomace composted with other green wastes may provide suppressive action against *V. dahliae* in soil. Raw olive pomace and the composted product were applied as treatments at a grower standard rate of 8 tons per acre by mixing into a soil artificially contaminated with *V. dahliae*. The efficacy of both amendments was determined using soil assays. After allowing the amendments to react with the contaminated soil, six-month old Arbequina olive trees were added and monitored for symptoms. Preliminary analysis suggests that the olive pomace in its raw state contains compounds that inhibit germination and growth and may have benefit in olive production as a soil amendment in fields with known *V. dahliae* pressure.

8:45 AM – 9:00 AM

Screening Pomegranate Varieties for Resistance

to Anthracnose Leaf Spot Caused By *Colletotrichum* spp.

Xinjie Yu; Katia Xavier; Gary E. Vallad and Zhanao Deng*, University of Florida

Pomegranate, an emerging crop in the Southeast U.S., is plagued by anthracnose leaf spot disease caused by *Colletotrichum* species. Identifying pomegranate varieties with resistance to anthracnose leaf spot is needed for integrated management of this disease. This study was conducted to define proper conditions for detached leaf assays and identify anthracnose leaf spot-resistant pomegranate varieties. Results indicated that pomegranate leaf age at the 4thpair, inoculum at 10^{6}conidia/mL, incubation temperature at 25°C, and 0-6 hours of light during incubation were favorable for disease development on detached leaves. Out of 17 pomegranate varieties screened using the detached leaf assay and a whole plant inoculation assay, 'Bhagwa' was consistently highly susceptible to the disease whereas 'Parfyanka' showed a moderate level of resistance. Conidiaof*Colletotrichum gloeosporioides* inoculated onto'Bhagwa' and 'Parfyanka' leavesdid not showsignificant differences in germination and appressorium formation; however, theconidiainoculatedon'Bhagwa' leaves had a lower percentage of infection peg formation and produced more new conidia than on 'Parfyanka' leaves. These results indicate that pomegranate varieties differ in susceptibility to anthracnose leaf spot. The identified resistant variety may be useful as a tool for managing anthracnose leaf spot disease and as a breeding parent for developing new resistant pomegranate varieties.

Specified Source(s) of Funding: USDA and FDACS Specialty Crop Block Grant Program projects (USDA-AMS-SC-BGP-2015/FDACS Contract #99169; USDA-AMS-SC-BGP-2017/FDACS Contract #024057).

9:00 AM – 9:15 AM

Fresh Eating Jujube Cultivars in the Southwestern United States

Shengrui Yao* and Robert Heyduck, New Mexico State University Sustainable Agriculture Sciences Center

There is a very limited number of jujube cultivars commercially available in the United States and Li as the dominant one. Both growers/home gardeners and consumers are frustrated with limited cultivar choices. We imported cultivars directly from China and collected cultivars across the U.S. After nine years of observation, some fresh eating cultivars in our collection are ready to be recommended to growers and consumers. 'Alcalde #1' is the earliest to mature, and has large fruit (>25 g) and good flavor which will be extremely valuable in marginal areas with a short growing season. It also does well in USDA zones 7a and 8a trial sites. 'Sandia' is a late maturing cultivar with excellent flavor and fine texture, suitable for zones 7 and up, marginal in zone 6. 'KFC', the most productive cultivar in the Alcalde trial, is a medium-sized, midseason fruit with excellent quality. 'Honeyjar', 'Maya' and 'Russian 2' all have excellent flavor, are early or mid-season and productive but with small fruit size (6-8 g) which will be suitable for home gardeners. The higher labor cost in picking small sized fruit should be considered in commercial production. 'Sugarcane' is sweet with medium sized fruit, good for both fresh eating and drying. 'Li', 'Shanxi Li', 'Redland', 'Dabailing', and 'Daguazao' are large-fruited cultivars, very productive with good flavor. These may be picked when fruit are partially or fully colored. Early picking before creamy stage results in lack of flavor.

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Specified Source(s) of Funding: Specialty Crop Block Grant through New Mexico Department of Agriculture

Viticulture and Small Fruits 2

Moderator: Timothy Jacobs
California Polytechnic State University-San Luis Obispo, San Luis Obispo, CA, USA

8:00 AM – 8:15 AM

High Density Planting Accelerates and Enhances Black Raspberry Productivity Under High Tunnels

Courtney A Weber*, Cornell Univ

Black raspberry (*Rubus occidentalis*) fruit is a common sight in Midwest and Northeast U.S. farm markets and is highly prized for its excellent eating and processing qualities. High phytochemical content and antioxidant potential has also led to a large number of studies on the health benefits of black raspberry consumption, with very positive results. Unfortunately, these qualities have not led to a large increase in production in these areas, primarily due to low productivity of plantings. While price surveys find a price premium for fresh black raspberries compared to red, the relatively low yield compared to red raspberry has kept them at a disadvantage from a production standpoint. The advent of high density plantings in tree fruits and strawberries has contributed to significant increases in yield per area and thus economic viability for growers. Typical crown growth and cane production in black raspberry suggests high density plantings may be useful in increasing overall productivity in this crop. A high density planting system for black raspberry production under high tunnels was designed and implemented to compare its productivity to standard planting recommendations for high tunnel black raspberry production. Green plugs of 'Bristol' and 'Jewel' were planted at high (17,932 plants·ha^{-1}) and standard (6,725 plants·ha^{-1}) density in a high tunnel and harvested for 3 seasons. In the high density system, 2 canes from each crown were precisely trained onto a narrow V-trellis to a height of approximately 2.1 meters each year with extra canes being removed. Standard density was variable based on crown and cane vigor typically observed in black raspberry and pruning was based on standard recommendations. Full productivity was reached in the 1st year after planting in the high density system and in the 2nd year at standard spacing. Yield was equal to or greater in the high density system in all years and cumulative yield over 3 harvest seasons was 15.8 $t{\cdot}ha^{-1}$ and 17.4 $t{\cdot}ha^{-1}$ for 'Jewel' and 'Bristol', respectively. This represented a 38% and 45% yield advantage, respectively, compared to standard plant density. Fruit size was marginally negatively affected in the higher density planting. Yield compared very favorably to previous open field red and black raspberry trials as well as high tunnel floricane red raspberry yields. A high density planting with precision training shows very good potential for improving the economic viability of black raspberry production in climates similar to western NY.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture, Hatch project NYG-632441

8:15 AM – 8:30 AM

High Tunnel Production of Strawberries Using Two Different Mulch Materials

Geoffrey Lalk*; Tongyin Li and Guihong Bi, Mississippi State University

Strawberry (*Fragaria* x *ananassa* Duch.) is the most popular berry crop in the US, and is one of the most popular items at local market outlets. A high tunnel allows growers to produce strawberries during off season when prices are at a premium. Off season production coupled with an increasing demand for locally grown produce could be a great economic benefit to growers operating on small- to medium-scale farms. Eight strawberry cultivars (Albion, Camarosa, Camino Real, Chandler, Fronteras, San Andreas, Sensation, and Strawberry Festival) were planted into a high tunnel in Nov. 2017. Strawberry plants were planted in raised beds in double rows covered with black or red plastic mulch. Strawberry plants were evaluated for their vegetative growth, timing of first fruit production, and berry yield. Strawberry quality parameters including single berry weight, berry firmness, total soluble solid content, and titratable acidity were also investigated. There were 20 harvests between 9 Mar. 2018 and 5 June 2018 with all cultivars producing berries near mid-March. 'Fronteras' and 'Camarosa' grown with black mulch produced the earliest marketable fruit on 6 Mar. All cultivars produced their peak marketable yield in the second half of May or earlier. Six of the eight cultivars (Camarosa, Camino Real, Chandler, Fronteras, San Andreas, and Strawberry Festival) produced total marketable yield over 457 g berries per plant over the entire season. 'Camino Real' and 'Strawberry Festival' produced the highest total marketable yield of 559.3 g and 555.5 g berries per plant, respectively. 'Sensation' produced berries with the highest soluble solid content of 10.4% grown with red plastic mulch. 'Camino Real' produced berries with the lowest soluble solid content of 7.7% when grown with red mulch and of 7.4% when grown with black mulch. Season extension in high tunnels combined with appropriate cultivar choices has the potential to be a profitable production system for Mississippi strawberry growers.

8:30 AM – 8:45 AM

Improved Weed Management, Plant Growth, and Yield in Floricane Raspberry Grown with Plastic Mulches

Huan Zhang*[1]; Carol A. Miles[2]; Shuresh Ghimire[3]; Chris Benedict[4]; Inga A. Zasada[5] and Lisa Wasko DeVetter[4], (1) Washington state university, (2)Washington State University, NWREC, (3)University of Connecticut, (4)Washington State University, (5)USDA-ARS

Floricane red raspberry (*Rubus ideaus*) in northwest Washington is traditionally grown in raised beds with weeds managed through a combination of herbicide applications and hand weeding. Growers find establishing tissue culture (TC) transplants using this traditional method often results in reduced plant growth and yield, as well as poor weed management. Because TC transplants are increasingly being utilized by growers and cost more than traditional cane and root planting materials, growers are in need of new practices that improve TC plant establishment, weed management, and productivity. The overall objective of this project was to develop knowledge and practical strategies to improve establishment and yield of raspberry established as TC transplants using polyethylene (PE) and biodegradable plastic mulches (BDMs). Six treatments were established in May 2017 in a commercial 'WakeTMField' raspberry field in northwest Washington. Treatments included one PE mulch, four BDMs (BASF 0.5, BASF 0.6, Novamont 0.5, and Novamont 0.6), and a bare ground (BG) control, which is growers' standard practice. Cumulative weed growth, root lesion nematode (*Pratylenchus penetrans*; RLN) population densities, soil temperature and moisture, cumulative primocane growth, and fruit yield were evaluated from May 2017 through Sept. 2018. Overall, weed incidence was reduced from May to Nov. 2017 and soil temperature was increased 1.5 °C from May to Sept. 2017 in mulched plots compared to the BG control. In Sept. 2018, RLN population densities were greater in soils covered with PE mulch than Novamont 0.5 (350 and 116 RLN/100 g soil, respectively) and were greater in raspberry roots from plots treated with PE mulch than BASF 0.6 and the BG control (2605, 430, and 692 RLN/g root, respectively). By the end of the first growing season (Oct. 2017), average primocane height and numbers were 36 cm and 5 canes/hill greater, respectively, across mulched treatments relative to the BG control. Average fruit yield in 2018 was 34% greater in the mulched treatments than the BG control. Overall, PE mulch and BDMs improved weed management and TC raspberry growth and yield compared to the standard practice of BG cultivation.

Specified Source(s) of Funding: Washington Red Raspberry Commission, Washington Commission on Pesticide Registration, Novamont S.p.A, and Washington State Department of Agriculture Specialty Crop Block Grant program, USDA

NIFA Hatch projects 0011 and 10/7286.

8:45 AM – 9:00 AM

Effect of Sudangrass Cover Crop Residues and Soil Solarization on Weed and V*erticillium Dahliae* Populations in Organic Strawberry Production.

Timothy Jacobs*; Ashraf Tubeileh and Scott Steinmaus, California Polytechnic State University-San Luis Obispo

The effects of soil solarization and sudangrass (*Sorghum X drumondii* (Nees ex Steud.) Millsp. & Chase) cover crop treatments were tested on weed and *Verticilium dahliae* (Kleb.) populations on the Cal Poly Organic Farm, San Luis Obispo, CA. Sudangrass was grown, mowed and then developed into two treatments: surface mulch (CCM) or incorporated (CCI) into the soil. The sudangrass treatments and a control (NO CC) were tested with and without soil solarization (n=4). Maximum soil temperatures in solarized plots were 48°C at a soil depth of 5 cm and 42°C at a soil depth of 15 cm. On average, temperatures in CCM plots were 2-3°C lower than other solarized plots. Temperatures in all solarized plots were 10-15°C higher than non-solarized plots. In initial weed biomass assessments, taken 6 weeks after tarp removal, non-solarized CCI plots reduced weed biomass by 24.4% compared to the control (p=0.30). Non-solarized CCM plots reduced weed biomass by 95.6% compared to the control (p=0.002). All solarized plots resulted in similar reduction in weed biomass compared to the control with an average reduction of 97.1% ± 0.6% (p=0.001). Efficacy of solarization treatments decreased with time. In final weed biomass assessments, taken 15 weeks after tarp removal, the only solarization treatment providing a significant reduction in weed biomass compared to the control was CCI with solarization (p=0.047), resulting in 67% lower biomass than the control. CCM plots without solarization also provided significant control (p=0.016), reducing weed biomass to 84.1% of the control. Solarized CCI and solarized NO CC plots both reduced *V. dahliae* levels to 1.5 CFU/g compared to baseline levels of 13 CFU/g (CCI, p=<0.001) and 8 CFU/g (No CC, p=0.037). *V. dahliae* populations were unaffected in other treatments. Results indicate that soil solarization can help manage annual weed and *V. dahliae* populations in organic strawberry production. Sudangrass residues can reduce weed populations but have limited effect on *V. dahliae* populations unless combined with soil solarization.

Specified Source(s) of Funding: Organic Farming Research Foundation (OFRF), Harold G. Hull Assistantship

9:00 AM – 9:15 AM

Developing the Recommendations for Southern Highbush Blueberry Containerized Substrate Production

Yang Fang*; Patricio Munoz; Gerardo H. Nunez and Paul R. Fisher, University of Florida

Southern highbush blueberry production requires acidic and well-aerated soil with high organic matter. Thus, soil amendment cost represents around one third of the total initial investment for blueberry traditional production. As a result of the high establishment cost, it takes growers more than five years to archive profits. The number of years from investment to archiving profits can be reduced by increasing earnings in the early years of production, which is increasing yield per area or advancing fruit harvest season to enter the market when price is high. This goal may be achieved by planting optimal evergreen cultivars in containers with optimal soilless substrate under high-density spacing. In this study, five evergreen cultivars and advanced selections ('Vireo', 'Chickadee', 'FL06-19', 'FL09-216', and 'FL09-311') with different growth habits were tested. One-year-old plants were planted in 15-gallon pots with five combinations of pine bark, coconut coir, and perlite (T1 = 5:4:1, T2= 6:3:1, T3= 7:2:1, T4= 7:3:0, and T5 = 10:0:0). Plant height and canopy size were measured in fall and after harvest. Leaf nutrient concentrations were analyzed during vegetative growth (Sept.), after last vegetative flush (Dec.), and at fruit development stage (Feb.). Yields were measured and compared among cultivars, substrates, and harvest season. After 5 months of growth, plants did not show differences in height and canopy size among substrates. The effects of substrates on berry yield were not significant as well. However, plants with substrate T5 showed greater leaf copper, manganese, and calcium concentration than those with T1 in Sept., T1 in Dec., and both T1 and T3 in Dec., respectively. Plants showed significant differences in height, canopy size, leaf nutrient concentrations and berry yield among cultivars. After nine months of planting, all cultivars except 'Chickadee' produced more than 1.13 kg of total yield per plant which was equivalent to 11,300 kg/ha.

Vegetable Breeding 1

Moderator: Waltram Second Ravelombola
University of Arkansas, Fayetteville, AR, USA

8:00 AM – 8:15 AM

Effects of Interspecific *Capsicum* Grafting Combinations on Horticultural Performance

Andrey A Vega-Alfaro*[1]; Carlos V Ramirez-Vargas[2] and James Nienhuis[1], (1)University of Wisconsin-Madison, (2) Tecnologico de Costa Rica

Our objective was to observe the effect of interspecific grafting combinations among *Capsicum* spp. as compared to non-grafted and self-grafted checks. Three commercially available *C. annuum* cultivars (California Wonder, Dulcitico and Natalie) were chosen as scions, and grafted onto commercial cultivars Habanero Early *(C. chinense*) and Aji Rico (*C. baccatum*). Field trials were conducted at West Madison Agricultural Research Station (WM, Madison, WI) in 2017 and 2018 and on the campus of the Tecnólogico de Costa Rica in San Carlos, Costa Rica (CR) in 2018. No significant

difference was observed among grafted, self-grafted and non-grafted plants for marketable yield; however, at WM we did observe a 22 % increase in marketable yield in all scions grafted onto Habanero Early. Similarly, an average increase of 15% and 5% was observed in the Dulcitico-Aji Rico combination at WM for 2017 and 2018 respectively, whereas the combination Natalie-Aji Rico tended to decrease yield in by 9% over both years, suggesting scion by rootstock interactions. Significantly higher yields were observed at WM in 2017 compared to CR. Aji Rico rootstock tended to result in reduced days to flower on Dulcitico and Natalie scions across all locations when compared to non-grafted plants. Habanero Early rootstock tended to result in reduced days to fruit on all scions across all locations. Natalie grafted onto Habanero Early resulted in significantly larger fruit size compared to non-grafted plants. No differences in fruit quality characteristics were observed among grafted, self-grafted and non-grafted plants.

8:15 AM – 8:30 AM

Phenomic Analysis of Salinity Effects on Lettuce Plants

Neil Adhikari*[1]; Arnulfo Soria[2]; Ivan Simko[1] and Beiquan Mou[1], (1)USDA-ARS, (2)Hartnell College

Salinity is a rising concern in many lettuce-growing regions, limiting yield and productivity. Lettuce (*Lactuca sativa* L.) is sensitive to salt stress, which reduces biomass and causes other undesirable effects. Salinity tolerant lettuce varieties are the most economical and effective means to sustainably grow lettuce and maintain high yield and quality of the product. We sought to identify physiological traits important in salt tolerance that allows lettuce adaptation to high salinity while maintaining its productivity. Following-up on information from previous salinity tolerance studies, 5 sensitive and 5 tolerant cultivars and accessions were chosen in the current study for more detailed analysis of their reactions to salinity in growth chamber tests; they included crisphead, butterhead, romaine, and leaf types of cultivated lettuce and its wild relative (*L. serriola* L.). Physiological parameters were measured four weeks after transplanting two-day old seedlings into 4-inch pots filled with sand and hydrated with Hoagland nutrient solution. To understand the state of the photosynthetic apparatus, chlorophyll fluorescence parameters and leaf area were measured using the PlantScreen system (Photon Systems Instruments). The 10 genotypes showed a broad range of reaction to salinity, exhibiting zero to 64% reduction in leaf area and 16% to 67% reduction in fresh weight compared to control, with PI 253468 at the lower end and 'Laura' at the higher end of reduction for both parameters. Salinity treatment increased chlorophyll content 5% to 21% in all cultivated genotypes, while decreasing it 5% to 17% in wild lettuce. Photosynthetic CO_2 assimilation did not change significantly in response to salinity in any genotypes. Salinity significantly increased photoinhibition and photooxidative stresses, however, in the most sensitive accessions. These results suggest that cultivated lettuce may adapt to salinity, in part, via upregulation of chlorophyll synthesis in order to maintain photosynthetic activity. Further study is needed to better understand this phenomenon.

Specified Source(s) of Funding: California Department of Food and Agriculture

8:30 AM – 8:45 AM

Genome-Wide Association Study (GWAS) and Genomic Selection (GS) for Drought Tolerance in Cowpea at Early Vegetative Stage

Waltram Second Ravelombola* and Ainong Shi, University of Arkansas

Cowpea is a legume offering good quality nutrition to the human's diet. Cowpea is cultivated on more than 14 million hectares worldwide. However, drought stress has been shown to have devastating impacts on cowpea production. Developing drought-tolerant cowpea cultivars could be an alternative to alleviate drought-related issues in cowpea. Therefore, this study aimed to conduct a genome-wide association study (GWAS), identify single marker polymorphism (SNP) markers, perform genomic selection (GS), and evaluate GS accuracy for drought-related traits in cowpea. The experiment involved a total of 331 cowpea genotypes, which were phenotyped in a greenhouse using 3 blocks (time). Of the 331 accessions, 234 were genotyped using a total of 1,006 high quality SNPs postulated from genotyping-by-sequencing (GBS). Phenotypes were collected before applying drought stress, at the time where 50% of the susceptible control displayed chlorotic unifoliate leaves, and when all plants for the susceptible control were completely dead. Soil moisture was recorded weekly. Phenotypic data consisted of plant height, stem diameter, chlorophyll content, plant greenness score, number of plants showing chlorotic unifoliate leaves, number of plants showing first chlorotic trifoliate leaves, average ratio between green trifoliate leaves and chlorotic trifoliate leaves, number of dead plants, number of plants showing dead growing points, and wilting dynamics of the genotype. A large variation in these phenotypic data is expected among the association panel. GWAS will be conducted using TASSEL, GAPIT, FarmCPU, and BLINK. Significant SNPs (LOD>3) and overlapping SNPs between traits will be identified. GS will be conducted using rrBLUP, gBLUP, BLR, RF, and SVMs. We expect that GS accuracy will depend on the trait and GS models. These results can be used in cowpea breeding for drought tolerance.

8:45 AM – 9:00 AM

Yellow Pods, Low Carotenoids and a Candidate Gene for the Snap Bean Wax Pod Trait

James R. Myers*[1]; Lyle Wallace[1]; Haidar A.H. Arkwazee[1]; Joel Davis[1]; Rian Lee[2] and Phillip E. McClean[2], (1)Oregon State University, (2)North Dakota State University

Snap beans with yellow pods or so called "wax" beans have been known for more than two centuries. They constitute a minor market class of snap beans with some popularity among fresh market growers and processors looking to increase color diversity in their product. The trait is controlled by a single recessive gene designated as *y*. Being easy to classify visually, *y* was used to construct the first pre-molecular marker linkage maps in common bean. In early molecular mapping efforts with RFLP markers, *y* was mapped to the distal end of Pv02 in a wax bean by wild bean cross. Using the BARCBean6K_3 Beadchip, we were able to obtain the physical location of *y* in two biparental populations ('Unidor'/'OSU5630' and 'Serin'/'OSU5630') and through association mapping in the Bean CAP Snap Bean Diversity Panel (SBDP). The data from these three sources point to a 122 kb region of Pv02 where the gene is located. The interval contains approximately 43 gene models. Using RNA seq data, we identified a pentatricopeptide repeat (PPR) gene that showed relatively high expression in flowers and young and old pods, but not in other tissues. PPR proteins are modular RNA-binding proteins that often control gene expression in both mitochondria and chloroplasts and expression in latter case may produce an albino phenotype. Data from the Bean CAP SBDP revealed that despite their yellow color, wax beans have the lowest levels of carotenoids of all snap beans. Using electron microscopy, we examined the chloroplasts in leaves and pods of wax and normal beans, and found that wax bean pod chloroplasts possess rudimentary thylakoid stacks compared to normal beans. Our hypothesis is that a PPR protein targeted to pod chloroplasts is a defective version of *y* that interferes with chlorophyll synthesis and carotenoid accumulation. While not so different in flavor and other qualities, our research shows that wax beans are not a useful source of carotenoids.

Specified Source(s) of Funding: OSU Baggett-Frazier Endowment

9:00 AM – 9:15 AM

Genetic Diversity and Population Structure Analysis of Common Bean

Jun Qin[1]; Ainong Shi[*1]; Thomas E. Michaels[2] and Senyu Chen[2], (1)University of Arkansas, (2)University of Minnesota

Common bean (*Phaseolus vulgaris* L.) is one of the most important edible legume crops worldwide. The objective of this research was to conduct genetic diversity and population structure analysis of a world-wide collection of common bean accessions using single nucleotide polymorphism (SNPs) markers. Whole genome resequencing (WGR) was used to discover SNPs in a panel of 355 USDA GRIN common bean germplasm accessions originally collected from 46 countries. The WGR was done with 10× coverage (about 7 Gb sequencing data each accession). A total of 24.4 M SNPs among the 355 common bean accessions were identified on 11 chromosomes ranged from 1.47 M SNPs on chromosome 6 to 2.93 M SNPs on chromosome 8. The model-based program STRUCTURE 2 was used to infer population structure. Genetic diversity was assessed and the phylogeny trees were drawn using MEGA 7 based on the Maximum Likelihood tree method. The analysis resulted in a phylogentic tree with two clusters reliably separating all 355 accessions. The genetic diversity and population structures were associated with geographic collections. These data could provide genetic diversity information for breeders to select and use these accessions as parents in common bean breeding programs.

9:15 AM – 9:30 AM

Development of New High-yielding Okra (*Abelmoschus esculentus* L. Moench)

Olagorite Adetula*, National Horticultural Research Institute

Okra (*Abelmoschus esculentus* L. Moench) is one of the most important annual vegetable crops cultivated in Africa. Okra is highly rich source of vitamins, minerals, and iodine. Twenty Okra germplasm collections from different parts of Nigeria were characterized and evaluated in a randomized complete block design with three replications for selection for development of new variety. Out of the 20 genotype evaluated $NHOLAK_2$ and $NHOLAK_5$ were farmers' preference and were identified as the best genotype to develop F_1 hybrid with high yield. Pure line selection was used to improve the yield and early maturing spineless fruit with good cooking qualities. The F_1 obtained after crosses were made between $NHOLAK_2$ and $NHOLAK_5$ was selfed until F_6 to obtain pure line. Morphological characterization including the fruit set and seed setting of the pure lines of improved varieties and others commercial varieties (NH47/4 and LD88) were carried out at National Horticultural Research Institute (NIHORT) Ibadan, Nigeria. The performance of the newly developed variety and the popular commercial varieties as check under multilocational trials in different Agroecological zones revealed the superiority of the hybrid with the highest mean yield of fruit of 800g/plant over two seasons. The $NHOLAK_7$ was further evaluated in farmer's field in five locations and the mean yield was 950 g/plant. The overall mean yield was 970 g/plant with an estimated yield of 35t/ha which was 10% more than the commercial check recorded 25t/ha.

Vegetable Crops Management 3

Moderator: Juan C Diaz-Perez
University of Georgia, Tifton, GA, USA

8:00 AM – 8:15 AM

Improving Crop Management for Hops Production in Florida: Effects of Plant Density and Nitrogen Rate on Plant Growth, Yield and Cone Quality.

Aleyda Acosta Rangel[*1]; Tiare Silvasy[1]; Jack Rechcigl[2]; Shinsuke Agehara[1] and Simon Bollin[3], (1)University of

Florida, (2)Univ of Florida/IFAS/Gulf Coast REC, (3)Hillsborough County Economic Development
Florida's subtropical climate allows two growing seasons (spring and fall) of hops (*Humulus lupulus*) per year. Supplemental lighting also plays an important role in creating two growing seasons by regulating the timing of flowering. Optimal crop management must be developed to maximize the yield potential of hops. In this study, we aimed to determine the optimal in-row plant spacing and nitrogen application rate for newly established hops in central west Florida. Tissue culture seedlings of 'Cascade' hops were established in a 5.8-m high trellis in February 2018. Harvests were performed in June in the spring season and December in the fall season. Treatments consisted of three levels of in-row plant spacing (76, 91, and 107 cm) and four nitrogen application rates (32, 56, 82, and 107 kg/ha in the spring season and 77, 148, 219, and 278 kg/ha in the fall season) in a factorial combination. The hop yield showed a linear increasing trend with N rate in both seasons. The maximum hop yield (dry weight) during the spring and fall seasons was 237 kg/ha and 190 Kg/ha respectively, at the widest plant spacing and the highest N rate. Plant growth also showed an increasing trend with N rate and it was positive and highly correlated with yield ($r=0.85$, $p<0.001$). The hop plants grew up better during the spring season compared to fall with more branches and biomass. The plant height, the fast growth of the bines, and the number of nodes with branching showed a positive nitrogen application response only during the spring season, but it does not for the fall season. Moreover, hop cones in spring had better quality compared to the ones in fall in terms of total oil and alpha acid contents. This seasonal effect was much greater than the effect of N rates, which was observed as a linear increasing trend for total oil content in spring and alpha acid content in fall. The lower performance during the fall season may be due to the hit heat stress that plants experienced during the summer combined with shorter day length during the rapid bine growth stage. This experiment shows that 427 kg/ha during the first year of crop establishment could be produced in Florida's subtropical climates.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant Program (FAIN#: USDA-AMS-SCBGP-2017)

8:15 AM – 8:30 AM

Cantaloupe and Honeydew Yield and Quality Performance in Georgia

Andre Luiz B.R. da Silva*[1]; Timothy W. Coolong[1]; Kevin Crosby[2] and Bhimanagouda S. Patil[2], (1)University of Georgia, (2)Texas A&M University
In Spring 2018, eight varieties of cantaloupe (*Cucumis melo* var. cantalupensis) and honeydew (*Cucumis melo* (Indorus Group)) were evaluated for yield and quality characteristics in Tifton, Georgia. This variety trial was part of a larger nationwide trial that evaluated the impact of environment on variation of quality traits in melons as well as the ability of human pathogens to adhere to the surface of melon fruit. Melons were planted on 27 Mar. and grown using plastic mulch and drip irrigation following standard practices for the region. The trial was a randomized complete block design with four replicates. Fruit were harvested from 1-19 June and individually weighed to get size classifications. Fruit from a representative harvest were analyzed for rind thickness, firmness (8mm probe), total soluble solids, seed cavity area and netting pattern. 'Athena' which is an industry standard was the highest yielding cantaloupe, though it was not significantly different from 3 other varieties. 'Athena' had the highest yield of 9-count fruit and an average fruit weight of 1.9 kg. 'Infinite Gold' and 'Davinci' were had the highest flesh firmness ratings, while F-39 had the lowest firmness of all fruit trialed. 'HD252' was the highest yielding honeydew variety, with a yield of 38,400 $kg\cdot ha^{-1}$. Our data suggests that current industry standards are performing adequately in terms of yield and quality; however, new varieties may offer improved characteristics for food safety purposes.

Specified Source(s) of Funding: USDA-NIFA-SCRI- 2017-51181-26834

8:30 AM – 8:45 AM

Impact of Preplant Nitrogen on Growth and Development of Plant Tape-Grown Vidalia Onion

Timothy W. Coolong*, University of Georgia
As labor costs increase, Vidalia onion (*Allium cepa*) growers are looking for ways to automate labor intensive processes such as transplanting and harvest. Plant Tape technology is an automated planting machine, which uses transplants that are grown in a biodegradable tape. Vidalia onion transplants are typically produced in field beds, pulled and replanted as bare-root plants. There is often a time period between when the onion transplants are planted in the ground and when growth resumes. Therefore, many growers do apply nitrogen fertilizer prior to planting. Because PlantTape-grown plants are produced in a transplant cell it was anticipated that growth would resume quickly after planting. Therefore, the role of preplant nitrogen was evaluated. Two varieties, Plethora and Vidora were planted by hand and using the Plant Tape technology on 14 Nov. 2017. Plants received either 16.8 or 33.6 $kg\cdot ha^{-1}$ applied at planting or 17 days after planting, with all other fertilization managed the same. Trials were a split-split plot design with planting method and variety being main plots and fertilizer treatments being sub plots. Total yields were not affected by fertilizer treatment. However, total yields were significantly lower in both varieties grown using the Plant Tape technology. Cull rates were significantly higher in plants grown using Plant Tape technology as well. Much of the reduction in yield was due to lower germination percentages and plant populations in the Plant-Tape grown plants as well as increased cull rates. Our data did not allow us to determine if supplemental nitrogen is required for Plant Tape-grown plants compared

to bare-root grown plants.

Specified Source(s) of Funding: Vidalia Onion Committee

8:45 AM – 9:00 AM

Bell Pepper (*Capsicum annum* L.) Fruit Yield and Quality Under Colored Shade Nets

Juan C Diaz-Perez*[1]; Kelly St. John-Pickel[2] and Juan C. Diaz-Perez[1], (1)University of Georgia, (2)Trellis Growing Systems LLC

Colored shade nets have shown benefits in bell pepper and other horticultural crops in Israel and other countries, although there is little information on use of colored shade nets on bell pepper in the U.S. The objective was to determine the effects of colored shade nets on fruit yield and quality of bell pepper. The study was conducted at the Horticulture Farm, Univ. of Georgia, Tifton, GA, during the spring of 2015 and 2016 in a sandy loam soil. Bell pepper ('PS 09979325') plants were grown on drip-irrigated raised beds; beds covered with black plastic film mulch. Each shade net was placed on a wooden rectangular structure (15 m wide x 6 m long x 5 m high). Experimental design was a randomized complete block with four replications and five treatments [5 shade treatments (black, red, silver, white, and uncovered)]. Results showed that mean and maximal air temperature and midday root zone temperature were highest in the unshaded treatment. Plant growth, measured as plant height and stem diameter were reduced in the unshaded treatment, although plant growth was unaffected by the shade net color. Leaf temperature was highest in the white and the unshaded treatments. Marketable and total fruit number and yield and individual fruit weight were reduced under unshaded treatment compared to all shading nets. The effects of colored shade nets on marketable fruit number and yield varied in the two year. in 2016, highest marketable yields were under silver net. The effect of shade nets on fruit soluble solids, total phenols, flavonoids, and antioxidant composition measured as CUPRAC (Cupric Reducing Antioxidant Capacity) and TEAC (Trolox Equivalent Antioxidant Capacity) also varied by year, although fruit under unshaded conditions had increased total phenols, flavonoids, and TEAC values. In conclusion, there were no consistent differences in bell pepper fruit yields among colored shade nets. Plant growth and fruit yield were reduced and fruit content of antioxidant compounds increased under unshaded conditions in both seasons.

Specified Source(s) of Funding: USDA-SBIR AWD00003638 and Georgia Agricultural Experiment Stations

9:00 AM – 9:15 AM

Characterization of Initial Post-Planting Root Development in Tomato and Pepper Transplants Using a Scanner-Based Rhizotron System

Atsushi Sanada*[1]; Jose Hernandez Monterroza[2] and Shinsuke Agehara[2], (1)Tokyo University of Agriculture, (2) University of Florida

Pepper (*Capsicum annuum* L.) transplants are generally more susceptible to transplant shock and establish slower in the field than tomato (*Solanum lycopersicum* L.) transplants, although they both belong to Solanaceae. Transplant shock is caused by the imbalance between root uptake capacity and shoot demand for water and nutrients. In this study, we used a scanner-based rhizotron system to examine their different post-planting growth from the perspective of root development. Each rhizotron had 2655 cm^3 of soil volume with a 22×30 cm scannable window on each side. Soil was collected from the field and packed in rhizotrons using the field bulk density. After tomato and pepper seedlings were transplanted in rhizotrons, root image analysis and growth measurements were performed periodically over 17 days. Tomato seedlings developed new roots at 3 days after transplanting (DAT), which reached the bottom of rhizotrons (30 cm) at 12 DAT. By contrast, pepper seedlings developed new roots at 5 DAT, most of which remained in the upper half of rhizotrons (15 cm). At 17 DAT, the longest primary root of tomato seedlings was 39% greater than that of pepper seedlings. Root image analysis also revealed that tomato seedlings had 24% to 52% larger root surface area than pepper seedlings at 5 to 7 DAT, indicating different root establishment rates in the two crops. Shoot growth differences between the two crops became apparent from 10 DAT. At 17 DAT, tomato seedlings had 117% larger canopy area and 163% greater nitrogen accumulation than pepper seedlings. These results suggest that different post-planting growth in tomato and pepper transplants can be explained in part by their different root initiation and exploration for soil nutrients immediately after transplanting. Strategies to promote initial root development may improve the stand establishment of pepper transplants.

9:15 AM – 9:30 AM

Switching Dry Granular Fertilizer Application to Fertigation Increases Potato Yield in Florida

Guodong David Liu*; Xiangju Fu; Lincoln Zotarelli and Steven A. Sargent, University of Florida

Potato is one of the most important crops grown in Florida. Dry granular fertilizer application is the traditional method for potato production with seepage irrigation. As Florida is one of the 14 states facing water shortage soon, conservative agriculture becomes more and more important. Overhead irrigation is partially replacing seepage irrigation for potato production in Florida. This replacement saves 58% irrigation water. However, dry granular fertilizer application is not suitable for overhead irrigated potato production. This study compared the yield difference between dry granular fertilizer application and fertigation with on-farm trials. These trials were conducted side-by-side with either chipping or tablestock potatoes on both private and research farms in northeast and southwest Florida from 2016 through

2019. The results show that fertigation increased tuber yield by 16% to 24%. Fertigation is the future for saving water and fertilizer for potato production in Florida.

Specified Source(s) of Funding: SWFWMD

9:30 AM – 9:45 AM

High-Tunnels Increase Water Use Efficiency of Peppers and Tomatoes Compared with Open Field Production in a Semi-Arid, Windy Climate

Hyungmin Rho*[1]; Paul D. Colaizzi[2]; Qingwu Xue[3] and Charlie Rush[3], (1)Texas A&M AgriLife Research - Amarillo, (2)USDA-ARS Bushland, (3)Texas A&M AgriLife Research

The Texas High Plains has a semi-arid, windy climate that features high evapotranspiration (ET) demands for crops. Irrigation is essential for vegetable production in the region, but irrigation is constrained by depleting ground water from the Ogallala Aquifer. Therefore, high-tunnel (HT) production systems may reduce irrigation water demand, and protect crops from severe weather events (e.g., hail, high wind, freezing) of the region. The objective of this study was to compare water use efficiency (WUE) of high value vegetables grown in HT versus open fields (OF). We hypothesized that the protection from dry and high winds by HT would reduce water use in peppers and tomatoes. During the 2018 growing season, peppers and tomatoes were transplanted on two HT plots and two identical OF plots. Plastic mulch was used in combination with a surface drip irrigation system. Micrometeorological variables (incoming solar irradiance, air temperature, relative humidity, and wind speed), physiological parameters, and volumetric soil water were measured. Air temperatures were significantly higher during the daytime, and wind speed and light intensity were significantly lower in HT compared with OF. The plants appeared to adapt to larger quantum yield under ~20% less photosynthetically active radiation in HT compared with OF. Larger quantum yield resulted in higher photosynthesis rate during the daytime in HT. A concurrent higher transpiration rate likely benefited the plants in maintaining leaf temperatures under the warmer air temperature by 2.2°C inside HT during the daytime. The changes in photosynthesis and transpiration of the plants in HT decreased intrinsic and extrinsic WUE at the leaf level. However, at the whole plant level, because of the protection from dry, high winds, the plants in HT required less total water over the growing season compared with OF, resulting in increased WUE. The 2018 data showed that HT production may be economically justified in terms of increased WUE and severe weather risk mitigation for high value vegetable production on the Texas High Plains

Postharvest 3

Moderator: Christopher Watkins
Cornell Univerity, Ithaca, NY, USA

8:00 AM – 8:15 AM

Harvista Treatment Effects on Quality and Storage Disorders of 'Honeycrisp' Apples

Christopher Watkins*; Yosef Al Shoffe; Jacqueline F. Nock and Yiyi Zhang, Cornell University

Harvista (preharvest 1-methycyclopropene; 1-MCP) was applied to replicate rows of 'Honeycrisp' apples, either 2 weeks (early), 1 week (late), at 1 and 2 weeks (repeated), or at double rate 1 week, before first commercial harvest. Fruit were then untreated or treated with postharvest 1-MCP and stored at 0.5°C or 3°C for 20 weeks. Fruit quality and physiological disorders were assessed after 4 days at 20°C. Fruit from all Harvista treatments had lower internal ethylene concentrations (IECs) and were greener as indicated by higher I_{AD} values compared with untreated controls. The starch pattern indices were lower in the repeated and double treatments than in control and other Harvista treatments. After storage, Harvista-treated fruit were firmer, but effects of the different Harvista treatments were inconsistent. Effects of 1-MCP on IEC and I_{AD} values were greater at 0.5°C than at 3°C, but high incidences of soft scald, core browning and vascular browning, especially in Harvista-treated fruit at the lower temperature, confirmed that 3°C is the correct temperature for this cultivar. After storage at 3°C, Harvista-treated fruit had a higher incidence of bitter pit, but less skin wrinkling and senescent breakdown. 1-MCP treatment of Harvista fruit slightly decreased bitter pit incidence while greatly increasing that of core browning and leather blotch, and sometimes flesh browning and carbon dioxide injury. While Harvista may be a useful tool to delay harvest, effects on storage disorders must be taken into account, and caution used when 1-MCP applications are made to fruit after harvest.

Specified Source(s) of Funding: This research was funded by AgroFresh Inc., the NY Apple R&D Program, and NIFA Improving Quality and Reducing Losses in Specialty Fruit Crops through Storage Technologies (NE-1336) under 2013-14-483.

8:15 AM – 8:30 AM

Effect of Delay with or without 1-MCP for CA and D CA-CF Storage on Fruit Quality and Physiological Disorder Development in Apple Fruit

Yosef Al Shoffe*[1]; Jacqueline F. Nock[1]; Yiyi Zhang[1]; John DeLong[2] and Christopher Watkins[3], (1)Cornell University, (2)Kentville Research and Development Centre, Agriculture & Agri-Food Canada, (3)Cornell Univerity

The effect of delay for 3 or 10 d with or without 1-methylcyclopropene (1-MCP) treatment before the long term storage of controlled atmosphere (CA) storage and dynamic CA-Chlorophyll Florescence (DCA-CF) storage on fruit quality and physiological disorder development has been investigated. 'McIntosh' and 'Cortland' apples were harvested from four different blocks in Hudson Valley (HV), Champlain region, and western New York (WNY), while 'Red Delicious' fruit were harvested from four different blocks in HV and WNY. 'McIntosh' fruit were stored at 3 °C in CA (2kPa O_2/ 5kPa CO_2) and in DCA-CF (1kPa O_2/ 2.5kPa CO_2). 'Cortland' and 'Red Delicious' were stored at 0.5 °C in CA (2kPa O_2/ 2kPa CO_2) and in DCA-CF (0.7kPa O_2/ 1kPa CO_2, and 0.6kPa O_2/ 1kPa CO_2, respectively). Fruit quality and physiological disorders were assessed after 8 months and +1 or 7 d at 20 °C. The effect of delaying CA on fruit quality and physiological disorders was variable between regions for each cultivar. The results show that DCA-CF was better than CA in maintaining fruit quality for all apple cultivars from all regions after 8 months of storage. In addition, DCA-CF decreased incidences of superficial scald and external CO_2 injury. Also, a synergistic effect was found between DCA-CF+ 1-MCP on maintaining the highest flesh firmness.

Specified Source(s) of Funding: This research was supported in part by the NY Apple R&D, and the USDA National Institute of Food and Agriculture, Hatch project 2013-14-483, Improving Quality and Reducing Losses in Specialty Fruit Crops through Storage Technologies (NE- 1336).

8:30 AM – 8:45 AM

Characterizing the Apple Fruit Microbiome: Spatial, Temporal, and Management Factors Influence Microbial Diversity

Michael Wisniewski[*1]; Samir Droby[2]; John Norelli[1]; Erik Burchard[1] and Dumitru Macarisin[3], (1)USDA-ARS, (2) ARO, (3)FDA

Accumulating evidence indicates that the composition of the microbiota inhabiting an organism (both endo- and epiphytically) can have a profound effect on host physiology. New correlations between specific microbiota and human health are being reported at a rapid rate. While significant efforts have been made in characterizing the rhizosphere and epiphytic microbiome of plants, much less attention has been placed on developing and harvested fruit, despite the potential impact of the microbiome on fruit physiology, postharvest disease, and food safety. Currently, efforts are being made to determine a core (common) apple fruit microbiome, the impact of management practices on the microbiome, and the identification of microbial consortia that can be used to inhibit postharvest diseases. Thus far, our investigation has revealed spatial and temporal changes in microbial diversity with clear distinctions between the microbiota of peel, stem-end, calyx-end, and wounded tissues. In general, bacteria appear to be impacted more than fungal taxa by sanitation practices, especially the epiphytic microflora of peel tissues. Coating fruit with a commercial wax favored the survival of bacterial pathogens that had been applied prior to waxing. An effect of apple pedigree on the endophytic population of microbes was also documented, suggesting that apple hosts and their associated microbiome have co-evolved, as suggested by the holobiont hypothesis. Ongoing studies are analyzing the microbiome of 'Royal Gala' apple fruit at harvest from seven different countries (18 different orchards) to determine if a core microbiome can be identified.

Specified Source(s) of Funding: U.S. - Israel Binational Agricultural Research and Development (BARD) Fund IS-5040-17

8:45 AM – 9:00 AM

The Use of 1-MCP and Ethoxyquin to Improve Ripening Capacity and Control Superficial Scald in Late-Harvested 'D'Anjou' Pears

Yu Dong[*], Oregon State University

'D'Anjou' pears is the most produced European pear (*Pyrus communis* L.) cultivar in the United States Pacific Northwest regions. In Hood River Valley, the recommended harvest maturity as indicated by flesh pressure is 67 to 58 N. At the optimal maturity, 'd'Anjou' pears have a relatively long storage life, low storage loss, and develop a buttery-juicy texture after 2-4 months of regular-air (RA) storage. However, due to labor shortages a significant portion of pears produced from high elevation is harvested later than the suggested maturity. Late harvest resulted in high superficial scald and inferior eating quality. In 2016, pears were harvested at 57 N (LH1) and 50 N (LH2) in the orchard of MCAREC, then treated with 150 and 300 ppb 1-MCP. The higher 1-MCP application dose showed the higher storage quality and lower scald, but totally inhibited the ripening. Partial pears treated with 150 ppb 1-MCP at LH1 and LH2 recovered ripening capacity with less scald after 6 months. In 2017, pears grown faster due to the hot growing season. Pears produced at 630, 1548, 1869 and 2204 ft and treated with 150 ppb 1-MCP recovered ripening after 5-7 months, but scald had developed. In 2018, pears were collected at 58 N from the orchard located at 630 ft, then treated with 150 ppb 1-MCP and 1000 ppn ethoxyquin, alone or in combination. The combination treatment had the positive effects in reducing scald and recovering ripening capacity. In conclusion, 150 ppb 1-MCP combined with 1000 ppn ethoxyquin might be used as a primary protocol for commercial application in late-harvested pears, especially in hot growing season.

Specified Source(s) of Funding: Northwest Fresh Pear Research Committees

9:00 AM – 9:15 AM

New Ethylene Antagonists Regulate Ethylene Action and Maintain Fruit Quality in Long Term-Controlled Atmosphere Stored Gold Rush Pear

Vijay Yadav Tokala[*]; Zora Singh; Alan Payne and Poe Nandar Kyaw, Curtin University

The plant hormone ethylene plays a key role in various ripening-related irreversible changes in the fruit. The fruit ripening process involves changes in rates of respiration and ethylene production, fruit softening, metabolism of sugars and acids, physiological loss of weight and depletion of bioactive compounds. The efficacy of two potential ethylene antagonists namely 1*H*-cyclopropabenzene (BC) and 1*H*-cyclopropa[*b*]naphthalene (NC) as well as 1-methylcyclopropene (1-MCP) in retarding the rates and delaying the onset of respiration and ethylene climacteric peaks as well as in maintaining the quality in 150 and 200 days controlled atmosphere (CA) - stored Gold Rush pear fruit were investigated. The Gold Rush pear fruit were fumigated with the ethylene antagonists for 18 h using 60 L hermetically sealable plastic drums and the untreated fruit were considered as control. The experiments were laid in one or two-factor factorial completely randomised design with four replicates and fifteen fruit per replication. The fumigation treatment with ethylene antagonists (BC, NC and 1-MCP) significantly ($P \leq 0.05$) reduced respiration and ethylene climacteric peak rates when compared to control, in 150 and 200 days CA-stored fruit. The pear fruit fumigated with ethylene antagonists maintained significantly higher fruit firmness and reduced physiological loss of weight (PLW) in comparison with the control fruit. The mean soluble solid concentration (SSC), glucose, and sorbitol values were maintained low in the CA-stored fruit fumigated with BC and NC. Levels of organic acids, total phenols, ascorbic acid, and total antioxidant capacity were not significantly affected by any of the ethylene antagonistic treatments. In conclusion, fumigation treatment with 1-MCP followed by BC and NC effectively reduced rates of ethylene and respiration but new ethylene antagonists were equally effective in maintaining postharvest fruit quality parameters studied in the long term CA-stored Gold Rush pear.

9:15 AM – 9:30 AM

Assessing Bitter Pit Prediction Methods for Honeycrisp Apples in Washington State

Felix Schuhmann; Marcella Galeni; Manoella Mendoza* and Ines Hanrahan, WA Tree Fruit Research Comm

All major apple varieties can develop preharvest and post-harvest disorders, which make them not marketable or lower their value drastically. The apple cv. Honeycrisp is especially susceptible to several pre and post-harvest disorders, but due to its high value, this apple is one of the top varieties planted in Washington State in the first two decades of this century. A major problem in Honeycrisp cultivation is that the fruit is prone to bitter pit, which is a physiological disorder characterized by dark and sunken spots on the apple surface. This disorder starts in the orchard, but symptoms may appear before harvest or during storage. High numbers of marketable fruit are lost every year to this particular damage. This indicates a need for an easy and inexpensive test that would allow producers to have a reliable indication of potential storage losses due to bitter pit. A total of four bitter pit prediction methods were evaluated between 2016 and 2018: Passive, ethephon (also known as Bangerth), hot water and PennState method. The hot water and PennState methods were evaluated for two consecutive years only. The number of orchards evaluated yearly ranged from three to five depending on the year. Before collecting the samples, the amount of bitter pit in the field was assessed for each orchard. Symptom free Honeycrisp apples were harvested a few days prior to first commercial harvest from the west or south side of the tree. The fruit was transferred to a laboratory where the protocol for each method was followed. A sub-sample of untreated symptom free apples was stored in commercial cold storage for up to 12 weeks. The development of bitter pit on apples in storage was compared to the prediction values resulting from each bitter pit prediction method. In general, there was a lot of variability between orchards and years, and none of the methods have demonstrated accurate prediction of potential storage loss due to bitter pit incidence across the years. It is important to take in consideration, that none of the methods above mentioned account for in field losses, which are the apples that present symptoms in the orchard and are not harvested. Nonetheless, overall the ethephon and PennState methods had a better prediction rate than the passive and hot water method.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

9:30 AM – 9:45 AM

Apple Fruit Responses to Controlled Atmosphere Established during Temperature Conditioning after Harvest

James P. Mattheis* and David R. Rudell, Tree Fruit Research Laboratory, USDA-ARS

Temperature management is a critical component of apple fruit postharvest systems. Cultivars differ in sensitivity to low temperature with development of some physiological disorders dependent on fruit temperature after harvest. A cooling protocol that holds fruit in air at an initial relatively high temperature (conditioning) followed by a lower final temperature can be an effective means to reduce physiological disorders for some cultivars. Temperature conditioning for disorder management is a strategy consistent with organic production but conditioning may limit storage duration due to excessive quality loss for conventional or organic fruit. Three cultivars, 'Fuji', 'Gala', and 'Granny Smith' with potential for fruit quality loss from delayed cooling in air were used to evaluate establishment of controlled atmosphere (CA) during temperature conditioning to impact physiological disorders while preventing excessive ripening. Results of a two-year study indicate some physiological disorders were impacted but quality was similar for conditioned fruit held in CA compared to fruit stored in CA at a lower temperature. The results indicate potential for postharvest management of these cultivars that maintains fruit quality while impacting physiological disorder development using existing technology compatible with organic production.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

9:45 AM – 10:00 AM

Apple Fruit Cutin Composition during Storage Is Altered By Sunlight Exposure in the Orchard

David R. Rudell*[1]; Brenton C. Poirier[1]; Loren A. Honaas[1]; Christine McTavish[2]; Carolina Torres[3] and James P. Mattheis[1], (1)Tree Fruit Research Laboratory, USDA-ARS, (2) USDA-ARS, (3)Washington State University, TFREC

Cutin is a polymeric protective coating of most aerial plant surfaces that is composed of primarily aliphatic mono, di, and tri-hydroxy fatty acids. Apple fruit cuticle is compiled of multiple layers of cutin overlaid and intercalated with a complex mixture of waxes and various freely soluble non-polar compounds. We extracted, hydrolyzed, and analyzed 'Granny Smith' apple cutin from stored fruit to determine if preharvest light exposure impacts postharvest cutin composition. Microscopic analysis revealed layered cutin periclinal and differential anticlinal deposition. Differences of cutin composition were also evident and continued to change with storage duration. Along with the freely extractable wax components, the dynamic composition and structure of this coating may govern gas, solute, and liquid transport influencing cell and fruit physiology to the point of altering fruit appearance or even ripening. Difference of cutin composition with sun exposure may provoke or be related to development of sunscald or other apple peel disorders.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

Weed Control & Pest Management 2

Moderator: Oleg Daugovish
University of California Coop. Ext., Ventura, Ventura, CA, USA

8:15 AM – 8:30 AM

Effect of Tissue and Sampling Season on PCR Detection of *Xylella Fastidiosa* in Peach

Chunxian Chen*, USDA, ARS, SEFTNRL; Clive H. Bock, USDA-ARS, SEFTNRL and Phillip M. Brannen, University of Georgia

Xylella fastidiosa (Xf) causes phony peach disease (PPD), which is incurable, vector-transmitted, and periodically rampant in affected peach production regions. In this presentation, we compared the effect of tissue type and sampling season on PCR detection of Xf in phony peach trees using newly developed primers. Among the four peach tissue types tested, only root samples demonstrated reliable and consistent detection of Xf; stem, petiole, and leaf samples, regardless of source trees, primers used, sampling times, or PCR methods, were unreliable for detection, due to insufficient quantity of DNA of Xf in these samples based on the relative quantification assay. Among the three sampling seasons, differences in detection were not obvious in terms of conventional PCR product band intensities, or not significant in terms of quantitative PCR qualification cycle (Cq) values. Furthermore, the Cq means and ratios were analyzed to compare the effects of source tree, tissue type, sampling time, and primer on detection sensitivity. In summary, only samples of root contained sufficient DNA of Xf for reliable and consistent PCR detection of Xf in phony peach trees. The newly developed primers are a useful resource for accurate detection and quantification of Xf, which is needed for epidemiological studies of the pathogen and disease, large-scale surveys of infected trees, and identification of resistant genotypes for use in breeding.

8:30 AM – 8:45 AM

Impact of Cover Crops on Soil Arthropods in High Tunnel Systems

Ashlee Skinner*; Raymond A. Cloyd; DeAnn Presley and Cary L. Rivard, Kansas State University

The use of high tunnel systems for vegetable crop production is increasing throughout the Central United States. High tunnels offer growers environmental protection, season extension, increased crop quality and yield, and pest and disease exclusion. In contrast to greenhouse production, high tunnels are typically soil-based. Intensive cultivation and/or reduced crop rotation intervals are typical in high tunnels and can lead to compaction and degradation of soil health. The objectives of this project were to identify summer and winter cover crop species that are viable for high tunnel systems and determine their impact on belowground arthropods and other soil health parameters. High tunnel trials were conducted in 2017 and 2018. There were eight cover crop treatments planted in each season, which included grass and legume *'Vicia villosa'* (hairy vetch) combinations as well as a bare ground control. In the overwintering season, cover crop contribution of available N (lbs./acre) to the growing system from rye *'Secale cereal'* was 103.70 (p-value <0.01), triticale *'Triticosecale'* and vetch 80.91(p-value <0.01), and the rye and vetch 70.17 (p-value <0.05) treatments. These treatments were significantly different from the bare control treatment. Soil characteristics including: water infiltration, soil moisture content, soil carbon, organic matter, and nitrogen were measured. Belowground arthropod abundance and trends were also monitored. At cover crop termination no belowground arthropods were found in all eight treatments (soil moisture content between 6 and 15%). Short-term changes in soil moisture resulted in changes in belowground arthropod abundance. Cover crops with high C:N ratios such as rye had higher mean abundance (11.5% more arthropods) than the average of all treatments. While there were no statistically significant treatment effects, "short–window" cover cropping resulted in changes in high tunnel soil ecology. This work is part of a collaborative multi-region OREI proj-

ect that is in collaboration with the University of Minnesota and the University of Kentucky, and is also supported by a 2018 NCR-SARE Graduate Student grant.

Specified Source(s) of Funding: North Central SARE

8:45 AM – 9:00 AM

Influence of Anaerobic Soil Disinfestation on Soil Microbial Community Changes in Field Tomato Production

Bodh R. Paudel*[1]; Haichao Guo[2]; Xin Zhao[1]; Erin N. Rosskopf[3]; Francesco Di Gioia[4]; Jason C. Hong[3] and David H. McNear Jr[5], (1)University of Florida, (2)Noble Research Institute, (3)USDA-ARS, (4)Pennsylvania State University, (5)University of Kentucky

Anaerobic soil disinfestation (ASD) has proven to be a promising and environmentally friendly alternative to chemical soil fumigation for controlling soilborne pathogens in a variety of crops. The change in soil microbial communities is considered one of the contributing factors for effectiveness of ASD. However, there is limited information about soil microbial ecology as affected by ASD in tomato production systems especially under low soilborne disease pressure. A field trial was conducted to assess the ASD effects on soil microbial communities during field tomato production in Citra, FL. A randomized complete block design with four replications was used, and the ASD treatments included two rates of molasses (6.9 m^3 ha^{-1} in ASD0.5 and 13.9 m^3 ha^{-1} in ASD1.0) and composted poultry litter (11 Mg ha^{-1} in ASD0.5 and 22 Mg ha^{-1} in ASD1.0), along with the chemical soil fumigation (CSF) control. Phospholipid fatty acid analysis was used to assess changes in soil microbial community composition during the production season at 0, 36, 76, and 99 days after transplanting (DAT) and at two soil depths of 0-15 cm and 15-30 cm. Total microbial biomass, Gram negative bacteria (G-), and G+:G- ratio were significantly impacted by the soil treatment × soil depth, soil treatment × time interactions, while actinobacteria, G+ bacteria, general fungi, and arbuscular mycorrhizal fungi (AMF) were significantly affected by the 3-way interaction between soil treatment, sampling time, and soil depth. Significantly lower concentrations of total microbial biomass and G- bacteria were found in CSF compared to the ASD treatments at both soil depths with greater differences at the 0-15 cm soil depth. Total microbial biomass and G- bacteria also showed higher concentrations in the soil at 0-15 cm than at 15-30 cm in both ASD treatments, but the depth difference was not observed in CSF. General fungi and G+ bacteria exhibited significantly higher concentrations in both ASD treatments than CSF at 0 DAT in 0-15 cm. The concentration of AMF in ASD0.5 at 36 DAT and ASD1.0 at 99 DAT in 0-15 cm was significantly higher than CSF at 36 and 99 DAT in both depths. The spatial and temporal changes in soil microbial community might also be impacted by soil nutrient availability. Overall, ASD could result in the preservation of greater beneficial microbial functional groups compared to chemical soil fumigation. Further research using high-throughput DNA sequencing may help identify key soil microbial functional groups.

Specified Source(s) of Funding: USDA ARS

9:00 AM – 9:15 AM

Effectiveness of Sulfur and Copper As Fungicides to Control Pawpaw Leaf and Fruit Spot.

Sijan Pandit*, Kentucky State University

Pawpaw is the largest tree fruit native to the eastern United States demonstrating potential as a fruit crop with commercial value. Leaf and fruit fungal spot a disease consisting of a complex of *Mycocentrospora asiminae*, *Rhopaloconidium asiminae* Ellis and Morgan, and *Phyllosticta asiminae* Ellis and Kellerm has been observed in pawpaw. Major symptoms include circular to angular or irregular, small to large tan spots with dark brown borders on leaves and dark brown to black spots on the fruit epidermis. Cracking of fruit is observed in severe cases. A positive correlation between fruit cracking and *Phyllosticta* coverage on the epidermis was found in previous research at Frankfort, KY. Sulfur and copper are essential nutrients for plants and are used to control many fungal diseases in plants. The objective of this study was to determine the efficacy of sulfur-and copper-based fungicides for the management of leaf and fruit fungal spot in 'Sunflower' and 'Susquehanna' cultivars of pawpaw. The experiment was conducted at the Kentucky State University (KSU) Harold R. Benson Research and Demonstration Farm in Frankfort, Kentucky in 2018. Fruit clusters were treated with two levels of each fungicide (sulfur at 25 or 50 ml/800 ml water or Copper at 3.12 or 12.5 ml/800 ml of water); water applied as a control. Insecticidal soap was used as an adjuvant in all treatments, including control, at 155 µl per 800 ml of water. Treatments were applied at 7- to 14- day intervals from 14th June 2018 to 23rd August, 2018. Quantification of disease on fruit was done by visually scoring the percentage of the fruit surface covered by lesions. Disease symptoms on leaves were quantified using Image-pro version 6.3 software. Data from untreated fruit clusters and leaves from the same tree were taken as an alternative control. The data were analyzed for analysis of variance and mean treatment differences using CoStat statistical software. In fruit, the high concentration sulfur and control had the least amount of disease coverage in comparison to other treatments and alternative control; alternative control had a significantly higher amount of disease coverage in comparison to other treatments. In leaves, all four treatments had significantly less disease coverage compared to control and alternative control. Single year data is not enough to draw a fixed conclusion about the effectiveness about these fungicides as results on fruit and leaves differed in this study; therefore this study should be replicated.

9:15 AM – 9:30 AM

End-Season Fumigation with Metam in Straw-

berry Reduced Infestations of Yellow Nutsedge and Soilborne Fusarium

Oleg Daugovish*, University of California Coop. Ext., Ventura and Tom Gordon, UC Davis

Strawberry remains a primary crop in coastal California with annual value > $2bln. At the end of fall-planted strawberry season plant collapse due to soil-borne wilt pathogen *Fusarium oxysporum* f. sp. *fragariae* and unrestricted growth of yellow nutsedge (*Cyperus esculentus*) are increasingly common. End-season fumigation of existing beds with metam products can reduce pathogen and weed survivorship and carryover into next production season. At Oxnard, CA we conducted two trials in 68-inch beds with end-season injections via two drip lines per bed in 2015 (213 lbs/acre of metam sodium) and in 2018 (174 lbs/acre of metam potassium). Nutsedge tubers and Fusarium chlamydospores (survival structures) in sand bags or pathogen infested strawberry crowns were placed at two depths and at two locations in beds. In both years 80-100% of nutsedge tubers germinated in untreated soil. Fumigants reduced shoot production from tubers under drip lines to 0-5% in both years, but between drip lines only to 35% (2015) and 53% (2018). Shoot production was similar at 6 and 12-inch depths. Fumigants provided nearly compete (>95%) control of Fusarium chlamydospores compared to untreated soil. As with nutsedge, pathogen mortality was consistently lower in soil between drip lines compared to locations under drip lines that supplied fumigants. Viable Fusarium recovery from infested crowns was 50-90% in fumigated soil and generally not different from untreated soil. Fusarium-infested crowns and roots are known to harbor pathogens from fumigants and that was the case in these trials. However, end-season fumigation with metam products was very effective in reducing soil-borne inoculum and nutsedge tubers at costs 40-60% lower compared to standard chloropicrin fumigation.

Citrus Crops 2

Moderator: Fernando Alferez
University of Florida, Immokalee, FL, USA

9:30 AM – 9:45 AM

Understanding Citrus Rootstock Fruit Maturation for Maximizing Seed Production

Fernando Alferez*; Daniel Adu Boakye; Tim Gast and Manjul Dutt, University of Florida

Seed availability of in demand rootstocks remain at an all-time high due to the severe pressure for replanting and resetting HLB-affected groves in Florida. Currently, there is a major concern among citrus nursery operators and growers for availability of vigorous seeds that can produce strong rootstocks for budding. The seed vigor however depends on seed maturation and can also be influenced by the extent of cold storage. In general, the more mature a seed, the longer it can be stored. The maturation stage at which citrus seeds from the major rootstocks can germinate is unknown. Natural calamities such as Hurricane Irma on September 10th, 2017 severely affected the ability of our industry to produce adequate seeds necessary to satisfy nurseries needs. In the hardest hit areas, there was massive fruit drop, especially from the US-802, US-812, US-897 and US-942 varieties and at a time when fruit was almost ready to be harvested and processed for supplying the seeds to the nurseries. Seed availability from the SWFREC Immokalee, USDA Fort Pierce, and Whitmore Foundation in Leesburg decreased by 66% as compared to previous season, resulting in a shortage in seed availability. For this reason, we started a research project to know in advance when the fruit contains viable seeds, with the purpose of make better decisions on harvesting. This will allow us to adjust the harvest of the fruit from each variety, facilitating to work around the peak of the hurricane season. We focused on identifying external, non-destructive markers to predict when the seeds are mature enough to germinate, and in determining seed shelf life under cold storage and the duration of seed viability depending on its maturation stage. Among markers assayed, we have been able to relate external peel coloration and responsiveness to ethylene and evolution of fruit abscission during fruit maturation with seed development in late-maturing varieties US-897 and US-942. As a result, we were able to advance fruit harvesting and seed extraction by 1.5 months, which resulted in an increase of 21% and 25% respectively in the number of viable seeds. These results will allow our industry to maximize seed production by advancing harvesting of late maturing rootstock varieties, which are among the most demanded by growers.

9:45 AM – 10:00 AM

Accelerated Production of Citrus Nursery Liners Using Automated Ebb-and-Flow Subirrigation

Rhuanito S. Ferrarezi*; Taylor Meadows; John Stephens; Herbert T. James III; Megan A. Eckman; Natalia P. F. Macan; Jude W. Grosser; Fernando Alferez and Tim Gast, University of Florida

Ebb-and-flow subirrigation is a closed system that applies water to the bottom of the containers, reducing water and nutrient losses due to recirculation of fertilizer solution (FS). The technology can accelerate plant growth and eliminate the improper disposal of salts into the environment. Sensor-based ebb-and-flow benches can be used by the citrus nursery industry to automate subirrigation operation and apply water on demand instead of on a rigid schedule. There is a need for establishing irrigation guidelines to produce different citrus rootstocks. The objectives of this study were: 1) automate ebb-and-flow subirrigation operation using soil moisture sensors, 2) evaluate the system performance on plant growth and water use, and 3) evaluate if subirrigation shorten crop cycle and accelerate citrus liners propagation time compared to overhead irrigation. The treatments tested were five irrigation methods [three ebb-and-flow subirrigation benches with different volumetric water content (VWC) to trigger subirrigation [Θ 0.24, 0.36 and 0.48 m^3/m^3], capillary mat and overhead irrigation] and six citrus rootstocks (Kuharske, UFR-2, UFR-16, US-802, US-812, and X-639), arranged in a 5×6 factorial split-plot design (irrigation method as main plot), with four replications. The system was automated by 20 capacitance sensors connected to a data logger, multiplexer and relay drivers, which controlled independent submersible pumps and solenoid valves. Subirrigation was turned on when VWC dropped below the set thresholds, while capillary mat and overhead ran on a rigid schedule. Sensors effectively monitored substrate VWC and controlled subirrigation. Treatments with highest VWC had higher substrate moisture and number of irrigations over time. Subirrigation at Θ 0.48 m^3/m^3 increased plant growth in 29% and reduced water use in 98% compared to capillary mat and overhead irrigation. Subirrigation shortened crop cycle and accelerated citrus liners propagation time compared to overhead irrigation, anticipating the liners transplanting for grafting. The volume of water applied was higher on capillary mat and overhead irrigation. VWC Θ 0.48 m^3/m^3 is indicated for liner production in cone-shaped containers. US-802, US-812, and X-639 rootstocks resulted in the tallest seedlings, while Kuharske showed the widest stem diameter.

Specified Source(s) of Funding: Funding for this research was provided by UF/IFAS and 2017-2018 FNGLA Endowment Research Fund.

10:00 AM – 10:15 AM

Developing Root Anatomical Markers to Predict Vigor Potential in Citrus Rootstocks.

Aditi D. Satpute*[1]; Indu Tripathi[2] and Ute Albrecht[2], (1) Southwest Florida Research and Education Center,University of Florida/IFAS, (2)Southwest Florida Research and Education Center, University of Florida/IFAS

In the epidemic of the devastating citrus disease huanglongbing (HLB), also known as citrus greening, Florida growers are seeking solutions to boost net returns on production. High-density planting is one promising strategy to fetch profitable returns during the early years of production before trees start to decline from HLB. Use of rootstocks that induce small tree size or dwarfing is key to the successful implementation of high-density planting in a commercial setting. In several fruit tree crops, tree vigor was shown to be associated with the xylem vessel anatomy, specifically the diameter of the vessel lumen. Other root anatomical and architectural traits such as root diameter, root hairs, and specific root length (SRL) may also play a role in the influence of rootstock on tree vigor. Root anatomical studies in citrus showed that root xylem vessel characteristics were related to the hydraulic properties of trees. The objective of this study was to decipher the xylem anatomy, specifically xylem vessel number, size, and arrangement, and other rootstock-specific traits that may be associated with tree vigor and productivity. We compared two commercial rootstock varieties, 'US-897' (*Citrus reticulata* Blanco x *Poncirus trifoliata* L.Raf) and 'US-802' (*C. paradisi* Macfad x *P. trifoliata*) which are known for their different vigor-inducing properties. 'US-897' induces small tree-size and production of high-quality fruit. In contrast, 'US-802' produces large trees with lower quality fruit. Our study showed that SRL (the ratio of root length to biomass of fine roots) was significantly higher in 'US-897'compared with US-802, suggesting a negative correlation of rootstock vigor and SRL. In addition, microscopical analysis of roots from two-year-old plants showed differences in vessel element (VE) arrangement. VEs in 'US 802' were mostly present in a pore chain arrangement where multiple pores (VEs) are arranged radially, while in 'US-897' more solitary pores and few pore chains were observed. There were no quantitative differences in the diameter of the VE lumen and vessel density between 'US-802' and 'US-897' in roots with different diameters. This study further investigated the importance of plant age, root order, and root diameter on the ability to predict rootstock influence on tree vigor. Characterization of the root system and root xylem architecture at a young age will be valuable for phenotyping citrus rootstocks in a breeding program and to predict the vigor control capacity of new citrus rootstock varieties.

10:15 AM – 10:30 AM

The Influence of Rootstock on the Metabolic Profiles of 'Valencia' Sweet Orange Trees – a Case Study Using Eleven Different Rootstock Varieties

Indu Tripathi*[1]; Kim Bowman[2] and Ute Albrecht[1], (1)Southwest Florida Research and Education Center, University of Florida/IFAS, (2)USDA-ARS

Commercial citrus production depends on the proper choice of rootstock. Rootstock influences tolerance of trees to biotic and abiotic stresses and influences horticultural traits, especially tree size, fruit quality, and yield. Grafting of scion on a rootstock results in a tree that is composed of two often genetically quite different units, and therefore influences the metabolic composition and physiology of the composite tree. In addition to rootstock effects on the scion, the scion is also likely to influence the physiology of the rootstock. In this study, we examined the metabolic profiles of eleven different citrus rootstocks grown as seedlings and as grafted trees in combination with 'Valencia' (*Citrus sinensis*) scion. Root metabolic profiles were established in seedlings and in grafted trees, and the influence of rootstock on leaf metabolic profiles was established in the grafted scion. Seedlings and grafted trees were one-year old and grown under controlled and identical conditions in the greenhouse. We used 11 citrus rootstock cultivars including 'Cleopatra' mandarin (*Citrus reticulata*), sour orange (*C. aurantium*), 'Ridge' pineapple (*C. sinensis*), and 8 hybrids of citrus and trifoliate orange (*Poncirus trifoliata*). Most of these varieties are widely used in commercial citrus production in Florida. Seedling roots, and roots and leaves of grafted trees were analyzed for their metabolite composition by gas chromatography time-of-flight mass spectrometry (GC-TOF MS). Partial least squares discriminant analysis (PLS-DA) revealed clear metabolic differences among rootstock cultivars in both seedlings and grafted 'Valencia' trees. Among the most discriminating root metabolites were hexitol, conduritol beta epoxide, galactinol, and nicotinic acid. Metabolic profiles were clearly associated with the taxonomic relationships among cultivars. Interestingly, in the unifoliate rootstocks, nicotinic acid, salicylic acid, and saccharic acid were found in considerably higher concentrations in the roots of grafted trees compared with seedlings; in contrast, in the trifoliate hybrid rootstocks, concentrations were lower in grafted trees than in seedlings. The reverse was found for quinic acid, allantoic acid, and shikimic acid. Analysis of leaf metabolic profiles in grafted trees showed discrimination of 'Valencia' trees based on the rootstock on which they were grafted. Leaf metabolites that discriminated most among rootstocks included beta-gentobiose, citrulline, hexaric acid, and ornithine. This demonstrates that rootstock influences a grafted scion metabolically. The results from this study are valuable for understanding rootstock–scion interactions, and for evaluating the positive and negative traits of rootstock and scion cultivars when they are deployed in graft combinations.

Specified Source(s) of Funding: Citrus Research & Development Foundation NIFA-SCRI-CDRE

Water Utilization & Management 2

Moderator: Oleg Daugovish
University of California Coop. Ext., Ventura, Ventura, CA, USA

9:30 AM – 9:45 AM

Recycling Irrigation Water at New Jersey Nurseries: Creation of a Comprehensivedecision-Making System

Robin G. Brumfield*, Rutgers, The State University of New Jersey; Paul Gottlieb, Rutgers,The State University of New Jersey and Raul I. I Cabrera, Rutgers University

Nurseries and Greenhouses represent the largest agricultural sector in New Jersey measured by dollar sales. Nursery production is relatively intensive with respect to chemical and nutrient inputs, and the industry seeks voluntarily to reduce its impacts on downstream water quality. Recycling irrigation and rainwater is more common in drought-ridden states like California than it is in New Jersey. Water recycling has obvious benefits in terms of water conservation and reduced runoff of nutrients and pesticides into the watershed. However, it has high up-front capital costs, possible recycling of plant pathogens along with water and fertilizer, and a complicated choice from among several disinfection technologies. We are creating a computerized capital investment decision tool for nursery operations throughout the U.S. The tool includes both financial and technical factors within a conceptual model that not only helps the environment, but also clarifies private return on investment. For at least some growers, the return on investment for recycling systems could be positive: it would useful for federal policy makers to know how common this phenomenon is. Focusing on small growers will ensure that the extension community is not misled by studying only large, sophisticated technology adopters whose capital investments are more likely to pay off. We met with extension experts in other states and vendors to obtain technical advice on what systems have worked and tested the quality of tailwater at the project test site as a benchmark for the condition of tailwater in the absence of recycling. We examined key papers in the research literature and found two methods of generalizing the dollar costs and benefits of investments in water recycling. In a top down approach, the researcher collects a large sample of financial data on a set of operations, pre- and post-investment and calculates average or typical dollar values to produce a software tool to determine "what you might expect to pay," etc. A bottom up replicates what a contractor would do when costing out a particular project for a particular operator. It uses real vendor prices for various components, adjusted to account for the size of the operation in water volume and/or acreage (e.g., $X per foot of pipe times 1000 feet of pipe). This approach handles mainly capital costs, not operating costs and operating benefits.

Recruiting local, small growers was a major challenge, similar to that faced by the EQIP program itself, so we have relied heavily on literature to develop our model. While smaller operators have the largest impact on the Cohansey watershed in the aggregate, they are, cautious about innovations and investments and are wary of government programs that provide funds, with the inevitable strings attached. Stresses about labor availability occupy operators' time.

The technical literature on the financial costs and benefits of water recycling has grown in quantity and quality since we made our own contribution to this literature in 2015. The literature finds a small number of factors dominate the profitability of water recycling. First, producers need to build a pond or regrade land for better water flow. Second, construction activities are so expensive that they tend to make the investment unprofitable. Third, if municipal water is the water source, it is so expensive per gallon that recycling will be cost effective in many of these cases. Fourth, recycling investments are less likely to be profitable on smaller operations due to economies of scale if capital costs are required for considerable earth moving such as pond construction and a new well. Producers who already have a suitable pond and are already considering drilling a well might receive positive gains from recycling.

We have created flowcharts for all components of the decision making took and have programmed the regulatory risk component of the software tool. We expect to complete the software decision tool and arrange for its evaluation by growers, vendors, extension personnel, and other experts within the next six months.

Specified Source(s) of Funding: IUSDA-NRCS CIG program

9:45 AM – 10:00 AM

Evaluation of Salinity Effects of Irrigation Water on Strawberry Cultivars

Andre Biscaro*[1]; Michael D Cahn[1]; Timothy K Hartz[2] and Stephen Grattan[3], (1)University of California Cooperative Extension, (2)University of California, (3)UC Davis
Strawberries are the third most valued crop in California ($2.3 billion) and the most sensitive to salinity. Limited information on the salt tolerance and chloride damage, associated with degrading quality of irrigation water, has led to significant yield losses in recent years. Strawberry yields, soil salinity and salts content in leaf blades of the two most popular public cultivars in California (Fronteras and Monterey) were assessed under eight salinity treatments on a randomized complete block design experiment in a commercial field located in Oxnard, CA during the 2017/2018 production season. The treatments consisted of increased salinity content of irrigation water, and they were determined based on irrigation water analysis from 40 commercial fields conducted during the prior season. The crop was planted on October 2017, and the salinity treatments were applied through the irrigation water delivered through the drip tape from November 2017 through June 2018. Irrigation amounts and timing were decided based on daily evapotranspiration estimations from a local weather station and based on tensiometer readings, respectively. Water-powered injectors mixed concentrated salt solutions with the irrigation water delivered on every irrigation from November 2017 to June 2018. The treatments consisted of two levels of elevated sodium adsorption ratio (SAR, 4.6 and 6.6), three levels of chloride (4.2, 7.7 and 11.7 meq/L), and two levels of elevated sulfate (18.3 and 26 meq/L of SO4). There were 60 drip irrigation events (2.0 acre-feet), and 54 harvesting days from December 2017 through June 2018. Composite soil and leaf blade samples were collected from each plot at early, mid and late production stages and analyzed for pH, ECe, Ca, Mg, Na, Cl, B, HCO3, CO3 and SO4-S (soil samples), and N, P, K, S, B, Ca, Mg, Zn, Mn, Fe, Cu, Na and Cl (leaf blade samples). Marketable yields of Fronteras were significantly ($P<0.05$) reduced with increasing chloride levels of 7.7 and 11.7 meq/L (13 and 17%, respectively). Although yields of all other treatments were lower than the control treatment, those differences were not statistically significant ($P>0.05$). Yields of the cultivar Monterey were not significantly affected by any treatment. Yield reduction of the cultivar Fronteras started before plant symptoms evident. Cull rates of both cultivars were not affected by the salinity treatments. Overall, the findings of this study conclude that the cultivar Fronteras is highly susceptible to elevated chloride levels, and that salinity effects on strawberry yield is cultivar dependent.

10:00 AM – 10:15 AM

Water and Salt Balance in Desert Cool Season Vegetable Cropping Systems

Charles A Sanchez*, University of Arizona; Andrew French, Aridland Research Center and Clinton Williams, USDA ARS ALARC
Water and salt management are of paramount importance to agricultural sustainability of vegetable crop production systems in the lower Colorado River region. Salinity of the available irrigation water coupled with capillary rise from slightly saline shallow ground water sources in the valleys can result in surface salinization. Maintaining acceptable root zone salinity levels requires some level of excess irrigation (beyond crop consumptive use) to leach salts below the crop root zone. A prerequisite to the utilization of leaching as a management tool is effective internal and external drainage. Salt sensitive cool season vegetables are planted from September through January and harvested from November through April each year. Studies were conducted from 2016 to 2019 to quantify water and salt balance in these production systems. Crop water use, represented by evapotranspiration (ET) was estimated using eddy covariance systems. Amounts of water applied by sprinklers was measured by automated gauges. Water measured by in-flow hydrographs was used to quantify water applied by surface irrigation. Soil salinity was monitored by electromagnetic (EM 38, Geonics Ltd., Mississauga, Canada) surveys and augmented by soil samples. The salinity in water and soils extracts was measured by conductance and the cations and anions measured by ion chromatography. Results show irrigation application efficiencies during the vegetable production period are high (>90%) and the required leaching is not achieved during the vegetable production period. Often the water management of the rotational crops in the spring and summer (wheat, Sudan grass, melons) do not result in the required leaching and a pre-irrigation before the cool season vegetable cycle begins is required for sustainability.

Specified Source(s) of Funding: Yuma Center of Excellence in Desert Agriculture

10:15 AM – 10:30 AM

Slow Sand Filters for Horticulture: What's Old Has Become New

John Majsztrik*; Natasha L. Bell; Lillian Kome; William Walker Spivey and Sarah A. White, Clemson University
Slow sand filters (SSF) were used to treat drinking water before the advent of modern water treatment systems. Recently, small-scale (column) studies of SSFs have demonstrated their potential to remove plant pathogen propagules from water. However, no evaluations of performance of mid- to large-scale remediation of nutrient or pathogen treatment efficacy were found in the literature. Thus, we installed two pilot scale SSFs (2.5M across, 2M deep) in South Carolina.

Each SSF was filled using water from a recycled irrigation pond, in a continuous-flow system through each SSF. Once a week about 400mL of *Phytophthoranicotianae*inoculum was added to each SSF, bringing total inoculum density above the sand layer to approximately 25 zoospores/mL. Each filter was spiked 1 time per week for 6 weeks. Effluent from each SSF was captured at least daily and the presence and activity of *P.nicotianae*was confirmed via leaf baiting bioassay. We monitored SSF startup (how long it takes for the microbial communities at the sand water interface to become active and help remove *P.nicotianae*) and long-term performance for presence and activity of *P.nicotianae*in both the influent (above the sand) and effluent. These SSF performed well, substantially removing *P.nicotianae*zoospores from solution, resulting in minimal breakthrough events during the establishment period and no breakthrough events after the short establishment. These SSFs required minimal maintenance and energy inputs for proper functioning, which is a benefit to growers. Some considerations of these systems that will be discussed include their relative size, treatment rate, and maintenance for optimal performance.

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10:30 AM – 10:45 AM

Management Practices to Minimize Stormwater Pollution from Macrotunnel Production Systems

Oleg Daugovish*[1]; Ben Faber[2]; Eta Takele[2]; James Whiteford[3] and Laosheng Wu[4], (1)University of California Coop. Ext., Ventura, (2)University of California Cooperative Extension, (3)Resource Conservation District, (4)University of California- Riverside

Macrotunnel production systems contribute over $1 billion to California's economy and are one of the State's fastest growing agricultural sectors. Despite their increased use, guidance to help macrotunnel growers choose management practices that limit agricultural pollutant loads in stormwater-induced runoff is sparse. Using raspberry as a model crop, four management practices were evaluated for their efficacy in preventing nutrient runoff, managing weeds and costs. The four treatment practices included in three-year raspberry production cycle were: barley cover crop seeded at 500 lbs/A, weed barrier fabric, yardwaste mulch spread 2-3 inches thick, and polyacrylamide (PAM). Treatments were applied to the 300 ft by 6 ft wide post rows that collect runoff from adjacent 22 ft wide plastic-covered tunnels. Barley cover crop and mulch reduced combined nitrate and nitrite nitrogen in runoff 21 to 48% but only at some runoff events, yet reduced nitrate nitrogen in soil and leachate by 52-90% minimizing potential losses to groundwater. All treatments significantly reduced turbidity and phosphorus levels in runoff and had 75-97% less sediment accumulation compared to bare soil. Reduced soil losses after implementation of these conservation practices may decrease regulated legacy pesticide loads traveling to receiving waterways, thereby achieving water quality goals. Additionally, all treatments except PAM reduced weed densities of little mallow and annual sowthistle 48-87% compared to bare ground, which reduces the costs of weed management. Efficacy of treatments in improving runoff water quality and weed suppression deteriorated as bare ground areas within treatments became more exposed, suggesting importance of maintenance of their integrity throughout the raspberry cropping cycle. Barley cover crop had the lowest estimated costs (~$60.00 per tunnel period), while PAM and mulch were highest (~$193.00 per tunnel period).

Specified Source(s) of Funding: California Department of Food and Agriculture- Specialty Crops Block Grant

Vegetable Breeding 2

Moderator: Gehendra Bhattarai
University of Arkansas, Fayetteville, AR, USA

9:45 AM – 10:00 AM

Single SNP- and Haplotype-Based Association Analysis of Anthracnose Disease Caused By *Colletotrichum Dematium* in Spinach (*Spinacia oleracea)*

Henry O. Awika*[1]; Kimberly Cochran[2]; Renesh Bedre[1]; Kranthi Mandadi[1] and Carlos A. Avila[1], (1)Texas A&M AgriLife Research, (2)Texas A&M AgriLife Extension

Anthracnose caused by *Colletotrichum dematium* is an important disease in commercial spinach fields resulting in up to 100% yield lost. Sources of genetic resistance need to be identified and molecular tools developed to expedite cultivar development. Unfortunately, since spinach has traditionally been treated as a minor crop, the development and use of genomic tools have been slow compared to more extensively cultivated crops. In this study we evaluated marker discovery for resistance to anthracnose by testing how well haplotype-based SNP-trait modelling compares to single-marker in identifying polymorphic features with strong association signal to anthracnose. Alleles in linkage disequilibrium (LD) were tagged in haplotype blocks, and the haplotype tag (ht) SNPs used in genome wide association study (GWAS). We also implemented the single maker testing to offer a comparison to haplotype-based tests in the same population. A diverse collection of 276 spinach accessions were inoculated and scored for disease severity. Anthracnose-associated molecular markers were identified using ddRADseq-generated single SNPs (SSNP), pairwise ht (htP) and multi-marker ht (htM). The results showed that after multiple testing correction, unique-marker anchoring genes identified by SSNP were 13, htP were 24 (~63% more) and htM were 34 (~162% more). Of these markers, 6 were uniquely identified using SSNP,13 uniquely using htP, and 19 uniquely htP. The results suggest that resistance to anthracnose is polygenic and that haplotype-based analysis may have more power than SSNP. We recommend the use of a combination of these methods for molecular marker discovery in Spinach.

Key words: Anthracnose, *Colletotrichum dematium*, haplotype, Spinach, SNP

Specified Source(s) of Funding: Texas A&M AgriLife

10:00 AM – 10:15 AM

Field Evaluation, Association Mapping, and QTL Analysis to Dissect Downy Mildew Resistance in Spinach

Gehendra Bhattarai*[1]; Ainong Shi[1]; James C. Correll[1]; Chunda Feng[1]; Braham Dhillon[1]; Jun Qin[1] and Beiquan Mou[2], (1) University of Arkansas, (2)USDA-ARS

Spinach (*Spinacia oleracea*) is an important cool-season leafy vegetable crop. A significant increase in spinach consumption in the last two decades in the U.S. is attributed to an increased consumer health-consciousness. Downy mildew (DM), caused by an obligate oomycete *Peronospora effusa* [=*P. farinosa f. sp. spinaciae* (Pfs)], is the most important disease affecting fresh-market spinach production in California and Arizona. Seventeen different races of Pfs have been reported in spinach and many of these races (> 10) were identified in the last two decades. Utilization of host genetic resistance is the most practical and economical disease management practice; it is particularly relevant in spinach as approximately 50% of the market is organic based. The rapid emergence of many new Pfs races, along with a regular breakdown of the resistance genes deployed in the major cultivars, indicates an urgent need to screen large germplasm set to identify novel qualitative and quantitative resistance alleles. More than 400 spinach genotypes, collected from 37 countries and maintained at NCRPIS, were evaluated at the USDA research station in Salinas, CA and the Yuma agricultural center at the University of Arizona from 2017-2019. Disease severity was rated on a scale of 0-100% based on a percentage of leaf area exhibiting downy mildew-infected tissue. A wide variation in downy mildew disease severity was observed among the evaluated spinach genotypes; GBS-generated SNPs were used to conduct an association analysis and significant SNPs were identified. Whole-genome resequencing of all evaluated spinach genotypes is underway. SNP markers identified from the population-resequencing approach will be used to conduct genome-wide association analysis. The purpose of the field evaluation was to identify resistance to the downy mildew pathogen under natural conditions. Field screening for downy mildew resistance can potentially identify partial resistance governed by QTL. Mapping of a cultivar segregating for Pfs 16 resistance and genome resequencing of bulked resistant and susceptible segregants from multiple populations segregating for Pfs 13 are being pursued. The selection for major and minor resistance in spinach to the downy mildew pathogen can improve the durability of resistance. Identification of markers associated with minor and major resistance alleles can be used in gene pyramiding to improve the durability of resistance of spinach cultivars against the various races of the downy mildew pathogen.

10:15 AM – 10:30 AM

Progress at Developing Genetic and Molecular Resources to Improve Spinach Production and Management

Ainong Shi*[1]; James Correll[1]; Chunda Feng[1]; Beiquan Mou[2]; Carlos A. Avila[3]; Larry A. Stein[4]; Rob Hogan[5]; Lindsey du Toit[6]; Jun Qin[1]; Gehendra Bhattarai[1]; Henry O. Awika[3]; Sanjaya Gyawali[6] and Shyam Kandel[2], (1)University of Arkansas, (2)USDA-ARS, (3)Texas A&M AgriLife Research, (4) Texas A&M University, (5)Texas A&M AgriLife Extension Service, (6)Washington State University

Spinach (*Spinacia oleracea* L., 2n=2x=12) is an economically important vegetable crop worldwide. The objectives of this spinach project are: (1) genetic mapping and SNP marker identification for downy mildew and white rust resistance; (2) QTL and association mapping, and SNP marker identification for Fusarium wilt resistance; (3) introgression of downy mildew and white rust resistance into spinach lines with diverse leaf quality characteristics to satisfy market demand; and (4) construction of high density SNP consensus genetic maps of the six chromosomes in spinach using whole genome resequencing. The project is a collaborative effort with the University of Arkansas, USDA-ARS at Salinas, Texas A&M AgriLife, and Washington State University. So far, 480 spinach genotypes have been evaluated for downy mildew, white rust, and Fusarium wilt resistance: downy mildew resistance was evaluated in Salinas, CA and Yuma, AZ during the winter of 2017-18 and winter of 2018-19; white rust resistance was/is being evaluated in a white rust nursery in Crystal City, TX and at Texas A&M AgriLife Research and Extension Center in Weslaco, TX during the winters of 2017-18 and 2018-19; Fusarium wilt resistance is being evaluated in the greenhouse at Washington State University Mount Vernon NWREC in Mount Vernon, WA. More than 20 spinach lines with high resistance to downy mildew, white rust, or Fusarium wilt have been identified. Nine F2 segregating populations have been evaluated for downy mildew. Thirteen, two and eight molecular markers have been developed for the loci RPF1, RPF2 and RPF3 for downy mildew resistance, respectively. A total of 440 spinach germplasm genotypes have been subjected to genome-wide association study (GWAS) and genomic selection (GS) for white rust resistance. Eight SNP markers were identified as a set to use for GS with a correlation coefficient (r) of 0.68 between the predicted breeding value and the observed white rust scale for 162 lines in a validation set, when another 250 spinach lines were used as the training set. GWAS is being completed for Fusarium wilt resistance, with SNP markers expected to be identified in 2019. The QTLs and SNP markers will provide breeders with robust tools to improve selection for resistance to these three economically important diseases of spinach through marker-assisted selection (MAS) and GS.

Specified Source(s) of Funding: USDA NIFA SCRI

10:30 AM – 10:45 AM

Development of Molecular and Phenotyping Selection Tools for Spinach Breeding

Carlos A. Avila*[1]; Devi Kandel[2] and Henry O. Awika[1], (1) Texas A&M AgriLife Research, (2)Texas A & M AgriLife Research and Extension Center

Spinach (*Spinacia oleracea*) production in the US has grown steadily during the past years, however production must thrive in a dynamic environment constantly challenged by abiotic and biotic stresses. Such stresses have a profound effect on quality and yield. Therefore, the current challenge in spinach production is to increase productivity by improving resistance and tolerance to diseases and environmental stresses. Due to the dioecious nature of spinach, breeding efficiency is very low using conventional methods. One of the major constraints to implement modern molecular breeding approaches used to be the lack of a good linkage maps and the lack of high-density molecular markers. But, with the advancements in next-generation sequencing for genotyping and the availability of a reference genome, it is now possible to identify markers associated to traits of interest. However, in order to precisely link these markers to traits of interest, it is required to phenotype large and diverse populations. Traditionally, phenotyping has been performed by manual measurements at single time points. The task is very time consuming and results in high variability due to human error. This report describes Texas A&M AgriLife Spinach breeding program efforts to develop molecular and phenotyping tools to improve breeding selection efficiency for cultivar development. Tools include development of high throughput phenotyping methodology using unmanned aircraft vehicles to monitor crop growth throughout the season and the development of molecular markers associated with plant growth, disease resistance, and abiotic stress.

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Weed Control & Pest Management 3

Moderator: Shuresh Ghimire
University of Connecticut, Vernon, CT, USA

9:45 AM – 10:00 AM

Comparison of Alternative Germplasm and Commercial Cover Crops for Improved Traits and Utility in Florida

Sunehali Sharma*; Carlene A. Chase; Marilyn E. Swisher and Kaylene Sattanno, University of Florida

Cover crops can contribute an array of agroecosystem services to cropping systems, including improving soil health and suppressing weeds and plant-pathogenic nematodes. Inconsistent seed availability or an undesirable trait may limit cover crop adoption. The commercially available sunn hemp (*Crotalaria juncea*) cultivars, Tropic Sun and AU Golden, have the perceived respective constraints of variable seed set within the continental US and low biomass production. ‘Iron Clay’ cowpea (*Vigna unguiculata*) produces hard seed that can result in volunteer plants emerging in subsequent cash crops. Therefore, alternative germplasm lines of sunn hemp (Sanni) and cowpea (US 1136, US 1137 and US 1138) were compared with corresponding commercially available cultivars to determine their suitability for Florida cropping systems. Additionally, an unnamed commercially available slenderleaf rattlebox (*C. ochroleuca*) variety and a slenderleaf rattlebox accession (PI274767) were compared. Field trials were conducted in summer 2018 on-station and at three organic farms in north-central Florida using a randomized complete block with four replications. Data were collected on cover crop biomass, weed biomass, weed density, and photosynthetically active radiation (PAR) penetrating the cover crop canopy. Total shoot biomass produced by Sanni, ‘Tropic Sun’ and ‘AU Golden’ did not differ significantly at any of the four locations. A significant difference in total weed biomass was observed at only one farm where Sanni resulted in less grass biomass production than the commercial cultivars. This contributed to lower total weed biomass production in Sanni than the commercial sunn hemp cultivars. The three cowpea germplasm lines produced similar or greater shoot biomass than ‘Iron Clay’ and suppressed total weed biomass as effectively as or better than ‘Iron Clay’. The PAR results indicated increased canopy closure over time that may partially explain the lower total weed biomass and densities with the cover crop treatments compared to the weedy control at eight weeks after planting. No significant difference in shoot biomass accumulation and weed suppression was observed with the slenderleaf rattlebox germplasm types. Shoot biomass production with slenderleaf rattlebox was comparable to cowpea and lower than sunn hemp; and may be an alternative to sunn hemp where lower biomass and less fibrous residue is preferred. However, additional work to optimize slenderleaf rattlebox seeding rates will be needed. The equivalent or better performance of the alternative germplasm lines of sunn hemp and cowpea indicate that Sanni, US 1136, US 1137 and US 1138 are suitable replacements for the commercial cultivars in Florida.

Specified Source(s) of Funding: National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2015-38640-23780 through the Southern Sustainable Agriculture Research and Education program, under subaward number LS16-270.

10:00 AM – 10:15 AM

Weed Control Assessment Utilizing Brewer`s Spent Grain, Paper Mulch and Cover Crops As Carbon Sources for Anaerobic Soil Disinfestation

Danyang Liu*[1]; Jayesh Samtani[1]; Charles Johnson[2]; David M. Butler[3] and Jeffrey F. Derr[1], (1)Virginia Tech, (2)Southern Piedmont AREC, Virginia Tech, (3)The University of Tennessee, Knoxville

Anaerobic soil disinfestation has been showed to be an effectively potential alternative method for chemical fumigant to control soilborne plant pathogens and several weeds. A series of greenhouse experiments were conducted to evaluate the effect of several locally available carbon sources for anaerobic soil disinfestation on certain weeds suppression. The potential carbon sources included rice bran (6t/acre), sorghum-sudangrass (6.4t/acre), cowpea (7.2t/acre), buckwheat (7.6t/care), paper mulch (3.1t/acre), brewer`s spent grain (6.04t/acre), used coffee grounds (10.64t/acre) and peanut shells (5.9t/acre) at 4 mg of C/g of soil. All trials were conducted in containers made by PVC tubes with 0.2 m tall and 0.15 m diameter. The viability of common chickweed, redroot pigweed, white clover and yellow nutsedge was reduced significantly and similarly with all C sources. Redox potential in all ASD treatments during the 3-week treatment period was lower than the nontreated control. Addition of distiller's yeast at 4.1kg/acre to C sources at 4 mg of C/g of soil, provided better or similar weed control than ASD treatments with C sources applied at the 4mg rate without distiller's yeast. The application of distiller`s yeast also enhance the effect of ASD treatments when C sources were brewer`s spent grain, coffee ground, peanut shell and riven bran. ASD treatments in all trials reduced weed viability in the 38 to 100% range compared to nontreated control.

Specified Source(s) of Funding: Virginia Tech College of Agriculture and Life Sciences

10:15 AM – 10:30 AM

Biodegradation of Biodegradable Plastic and Paper Mulches in the Field after Tillage Incorporation in Northwest Washington

Shuresh Ghimire*[1]; Ed Scheenstra[2]; Markus Flury[3] and Carol A. Miles[2], (1)University of Connecticut, (2)Washington State University, NWREC, (3)Washington State University

Biodegradable plastic mulch is incorporated into the soil after use, eliminating environmental and economic issues associated with mulch removal and disposal. Although biodegradable plastic mulches have been shown to provide comparable weed control, moisture conservation, crop yield and quality benefits to polyethylene mulch, there are concerns about incomplete biodegradation and potential negative impacts on soil quality and subsequent crop production. A few standards and methodologies (for example ASTM D 5988 or International Standards Organization; ISO 17556) measure in-soil biodegradation of the major ingredients of biodegradable plastic mulch under laboratory conditions where temperature, humidity, and oxygen levels are defined; but this is not representative of field conditions. We conducted a field study at Mount Vernon, WA to assess the amount of biodegradable mulch (fragment size > 2.36 mm) remaining in the soil each fall (within 1 month of mulch incorporation) and spring (6 months after mulch incorporation) for 3 years (2016-2018) in a field where five biodegradable mulches were applied and tilled into the respective plots each year. Treatments were four biodegradable plastic mulches, BioAgri [Mater-Bi® (grade EF04P), poly(butylene adipate-co-terephthalate) (PBAT); 20-25% biobased], Naturecycle (Starch-polyester blend; ≥20% biobased), Organix [BASF ecovio® (grade M2351), PBAT, polylactic acid (PLA); 10% biobased], and Experimental (Ingeo® PLA, Mirel™ amorphous Polyhydroxyalkanoates (PHA); 86% biobased), and one paper mulch, WeedGuardPlus (cellulose; 100% biobased). Percent mulch recovery was calculated with respect to the total amount of mulch applied. Average mulch recovery for the three commercial biodegradable plastic mulches in the fall was 71% (range 30-95%), 50% (41-69%), and 21% (18-25%) after first, second, and third applications, respectively. In the spring, average recovery for the same three mulches was 50% (31-67%) and 36% (21-53%) after the first and second applications, respectively (third sampling time is April 2019). For Experimental mulch, the average recovery was 60% (32-80%) in the fall and 66% (39-93%) in the spring. For WeedGuardPlus, average recovery was 15% in the fall, and no much was recovered in the spring (complete degradation). These results show that biodegradable plastic mulches degrade over time in the field, but complete degradation takes more than 1 year. Further, biobased content does not determine the biodegradation rate of the mulch. Tests additional to the current laboratory tests are needed to ascertain mulch biodegradation under field conditions, and long-term studies are needed to follow the degradation and fate of biodegradable plastic mulch in the field.

Specified Source(s) of Funding: National Institute of Food (NIFA) and Agriculture, U.S. Department of Agriculture, award number 2014-51181-22382

10:30 AM – 10:45 AM

Industrial Hemp: A Versatile Crop with the Potential to Improve Agroecosystem Diversity, Mitigate Environmental Degradation and Increase Farm Incomes

Tara A. Caton*, Rodale Institute

Industrial hemp, a versatile plant grown for its fiber, seed or oil, was a valuable cash crop and a major industry in Pennsylvania for more than 260 years prior to its ban in 1933. Due to its close relationship to the marijuana plant, hemp production became a casualty of a 1933 law banning marijuana, and was later named a Schedule 1 drug by the Controlled Substances Act of 1970. In 2017, Rodale Institute was one of 16 organizations that received a permit for the

inaugural planting of hemp in Pennsylvania in more than 80 years as part of the Pennsylvania Department of Agriculture Industrial Hemp Pilot Program. A four-year research project was initiated to evaluate industrial hemp varieties that are most suited to soil and climatic conditions in Pennsylvania. The project has two components; – a variety trial that aims to determine available varieties with greatest seed yield and fiber content and a weed suppression trial that aims to establish hemp as a dual cover to mitigate environmental degradation, and cash crop to increase farm incomes. Three varieties are being assessed for weed suppression, viability, height, hemp biomass, seed yield and effect on soil physical and chemical properties. The weed competition trial is evaluating potential of hemp to act as a substitute cover crop in common organic tilled and no-till crop rotations, as a weed suppression cover crop. Preliminary results indicate that both 'Santhica 27' fiber hemp variety and sorghum Sudan grass equally suppress weeds compared to control. The data indicate that hemp suppresses ragweed better than Sudan grass, while the latter suppresses lambsquarter better than hemp. Data also suggest that fiber hemp varieties and Sudan grass reduce soil bulk density. Our research will help growers make informed decisions and avoid costly mistakes when hemp is legalized.

Specified Source(s) of Funding: Dr. Bronner's

10:45 AM – 11:00 AM

Interactions between Quinoa (Chenopodium quinoa) and Three Common Weeds in a Replacement Series Study

Kristine Buckland*, Oregon State University

Quinoa (Chenopodium quinoa Willd.) is an ancient crop with the potential to increase worldwide food security if field management strategies can be optimize to allow for profitable production. Some growers within the US report quinoa's potential for competitive growth and tolerance to weed competition, yet weed control issues have led many larger producers to abandon the crop. Very limited herbicide options are currently available and the cost of labor and mechanical cultivation can be prohibitive. Understanding the interactions between weeds and quinoa is essential to developing an effective cropping system. This study uses a replacement series design with quinoa and three common weed species: lambsquarters (Chenopodium album L.), red root pigweed (Amaranthus retroflexus) and green foxtail (Setaria viridis) and two fertility levels (60 and 240 mg N kg soil-1) repeated in two independent runs. Over most treatment and planting ratio combinations, quinoa had greater biomass accumulation than both red root pigweed and lambsquarters. Tissue nitrogen accumulation was similar between quinoa and two weed species, foxtail and red root pigweed, but lambsquarters had greater tissue nitrogen than quinoa. Green foxtail was the most competitive weed species although results varied between trial runs, likely due to differences in ambient photoperiod. Further research into the impact of emergence rate and planting density under field conditions is required for to optimize quinoa planting recommendations.

Specified Source(s) of Funding: USDA OREI

Undergraduate Student 2

12:30 PM – 12:45 PM

Creating ADA Compliant Print and Digital Extension Publications

Grace Ragland*, LSU and Ed Bush, LSU AgCenter

Extension publications have traditionally been formatted identically for both print and digital format for decades. However, ADA compliance laws that went into effect in 2011 require additional measures in formatting and publishing our extension information. The objective of this study was to explore usage of various computer programs to comply with ADA regulations for users that are hearing, speech and/or vision challenged in order to meet and surpass the standard compliance level. Our experiences and results indicated that there is a general hesitance to publish in an ADA format due to lack of easy to follow instructions and examples of compliant publications, along with the fact that there are various levels of compliance that technically satisfy compliance regulations. The use of internet tutorials and a myriad of meetings with ADA compliance officers at our institution was helpful, although proper formatting, evaluating, and publishing compliant documents techniques are not widely known among faculty members or advisers. A Lynda tutorial, by Chad Chelius, provided basic skills and a step-by-step "how to" on creating and remediating ADA compliant InDesign, Word, PowerPoint, and PDF formatted documents. Challenging aspects of formatting extension documents included tables, charts, graphs, graphic diagrams, alternative text, read order, tag order, metadata, color contrast, captions, index, and table of contents. Usage of Adobe Acrobat Pro was helpful in screening for compliance errors post PDF export. There are everchanging resources and compliance standards guidelines being developed and modified for a clearer understanding of the topic. The authors sole purpose transitioned into to an instructional presentation to elucidate horticulturists about creating source documents that are in the proper format for publishing ADA compliant documents. Before submitting publications to an extension publication department, horticulturists should be trained to comply with these regulations and do our best to create publications that are accessible and equal for all users.

Specified Source(s) of Funding: SCRI funded all or part of the research associated with this abstract

12:45 PM – 1:00 PM

Vidalia Onion Awareness and Perceptions

Blake Carter*; Ben Campbell; Julie Campbell and Vanessa

Shonkwiler, University of Georgia
According to the USDA, onions are one of the most highly valued vegetables that Georgia produces, contributing over 131 million dollars to the economy. This has led to Georgia to name the Vidalia Sweet Onion as the state vegetable. However, even though Vidalia onions are grown only in a small area in Georgia, they are sold throughout the U.S. In marketing Vidalia onions throughout the U.S. it is essential that Vidalia producers understand awareness and perception of their product as the product moves away from the Georgia production region. Using an online consumer survey of around 1,500 U.S. consumers we examine how awareness and perceptions change as consumers move farther from the Georgia production region. In order to assess distance from the Georgia production region we calculate the distance, in miles, from the respondents reported zip code of residence to the zip code at the heart of Georgia Vidalia onion production. Utilizing logit models we then evaluate the role of socio-demographics and distance on awareness and perception. We find that as various socio-demographics impact awareness and perception of Vidalia onions. Further, we find that as distance increases awareness decrease and perceptions differ from those of consumers living closer to the Georgia production region. Using this information, Vidalia onion producers and industry stakeholders can assess how to improve awareness and perceptions for consumers throughout the U.S.

1:00 PM – 1:15 PM

Quantifying Growth Differences Among Pistachio Rootstock Siblings in Vitro

Cassandra Fordyce*[1]; John E Preece[2]; Franklin Lewis[1]; Daniel Potter[1] and Deborah Golino[3], (1)University of California, (2)National Clonal Germplasm Repository USDA-ARS, (3) Foundation Plant Services, UC Davis
UCB-1 is a hybrid pistachio rootstock (P. atlantica x P. integerrima) that is commonly used in commercial Pistachio production. Typically, growers use seedling UCB-1 rootstock; however, many orchards are grafted onto clonal UCB-1. It is wise replace these clones regularly because somaclonal variation may increase over time with micropropagated UCB-1 clones. Field-grown UCB-1 trees contain endophytes, therefore, new seeds must be introduced into sterile culture to produce aseptic clones. This study was to quantify the in vitro performance of 119 UCB-1 clones. Seeds were removed from the pericarp, surface disinfested in NaDCC, then placed on DKW media modified with 5µM BA and 80µM FeNaEDDHA with 30g of Sucrose and 6g of A111 agar. Data were collected every 4 weeks at transfer on shoot number and length, and callus volume on each of the 4 shoot reps/clone. At transfer, shoots were excised to reduce each culture vessel to a single shoot. There was substantial variation for in vitro growth among the seedling lines. Most clonal lines (70/120) elongated a single shoot; however, 2 clones produced at least two shoots (one primary and one axillary shoot) each month, which doubles the production rate of most clones. Likewise, most shoots were shorter than 2 cm tall after each month in vitro; however, 8 clones were ≥ 2 cm tall and 1 clone consistently grew to be over 3 cm tall at the end of each month. Ability to micropropagate efficiently, as seen with some seedling clones, is important for efficient commercial micropropagation.

Specified Source(s) of Funding: Funded in part by the California Pistachio Research Board

1:15 PM – 1:30 PM

Impact of Season and Rooting Hormone Rate on Root Number and Length for Propagated Olive Cuttings in Oregon

Tessa A Barker*; Heather Stoven and Javier Fernandez-Salvador, Oregon State University
Currently most Oregon olive growers purchase stock plants from California nurseries. As Oregon's olive industry grows, producers are looking to on-farm propagation to reduce costs. Determining best practices for olive propagation in Oregon is needed. The objectives of this study were 1) to evaluate four rooting hormone rates during three seasons to determine their impact on average primary root number and average root length, and 2) to determine which season is associated with the most successful rooting. On May 25, July 24, and Oct. 15, 2018, 96 8-cm cuttings were taken from mature Arbequina olive trees in Dayton, OR. Cuttings were dipped in one of four hormone treatments (3000ppm IBA, 8000ppm IBA, 2000IBA + 1000NAA, and 4000IBA+-2000NAA), and planted in 32-cell, 6.67 cm trays filled with 2:1 peat:perlite. Cells were organized in a completely randomized design in trays, and kept in a temperature-controlled greenhouse on benches with bottom heat and automated mist irrigation, at the North Willamette Research and Extension Center in Aurora, OR. Data was collected three months after each propagation date by counting total primary roots per cutting and measuring total root length for all roots 0.5cm or greater. Data was analyzed using ANOVA on SAS version 9.4. Season was significant ($p < 0.0001$) for root number and length, with spring having the greatest root number and length, followed by summer and fall (not statistically different). For spring propagation, hormone rate had a significant effect on root number ($p = 0.0004$) and length ($p = 0.0007$), with the highest rate, 8000ppm IBA, having the greatest average number of roots (12.5), and the highest average root length (65 cm). There were no significant effects from hormone rate treatments during summer or fall. In a sub-trial using covered trays with hand watering instead of mist during fall propagation, hormone rate treatments had a significant effect on root number ($p = 0.0384$) and length ($p = 0.0347$). In this instance, 3000ppm IBA was associated with the highest average root number (6) and length (27 cm). Comparing rooting success across seasons, the interaction of season and hormone rate was significant ($p < 0.0004$) for root number, but not length. Initial results suggest that

propagation season may have more influence on rooting success than specific hormone-rates, and that the interaction between season and hormone may have a greater effect than any treatment alone. This study will be replicated in 2019.

Specified Source(s) of Funding: WSARE

1:30 PM – 1:45 PM

Hardwood Propagation of Delta Jazz™ Crape Myrtle

J. Skylar Baldwin*[1]; Jenny B. Ryals[2]; Patricia R Knight[2]; Scott A. Langlois[2]; Eugene K. Blythe[2]; Christine E. H. Coker[2]; Gary R. Bachman[2] and James M. DelPrince[2], (1) Mississippi State University, (2)Mississippi State University Coastal Research and Extension Center

Mississippi State University has developed several new crape myrtle selections, including Delta Jazz™. Objective was to determine optimal hormone source and concentration for hardwood cutting propagation of Delta Jazz™. Medial cuttings (12.7 cm) were harvested and stuck to a depth of 2.6 cm on 1 Feb. 2017. Medium was 100% perlite in 7.6 cm containers. Treatments included two basal treatments (wounded or non-wounded), three hormone mixtures (Hortus IBA, Dip & Gro, or Hortus IBA + NAA), and three levels of hormone (0, 1000, or 5000 ppm IBA). Experimental design was a RBCD with five single plant replications. Data collected included percent rooting, new shoot growth, cutting quality, root number, average root length (length of three longest roots/three), and root quality. Rooting percentages were similar, regardless of treatment. Cuttings that were not wounded and dipped in 5000 ppm Hortus IBA or dipped in 5000 ppm Hortus IBA + 2500 ppm KNAA, regardless of wounding, had more roots than the control, cuttings dipped in 1000 ppm Hortus IBA, 1000 ppm Dip'N Grow, or 1000 ppm Hortus IBA + 500 ppm KNAA, regardless of wounding. Cuttings that were wounded and dipped in 1000 ppm Hortus IBA had higher average length of three longest roots compared to plants that received no hormone and not wounded. Root quality ratings were greater for cuttings dipped in 5000 ppm Hortus IBA or 5000 ppm Hortus IBA + 2500 ppm KNAA, regardless of wounding, compared to cuttings that received no hormone, regardless of wounding, or cuttings that were not wounded and dipped in 1000 ppm Dip'N Grow. Cutting quality ratings were higher for cuttings that were wounded and dipped in 5000 ppm Hortus IBA or cuttings that were dipped in 5000 ppm Hortus IBA + 2500 ppm KNAA, regardless of wounding, compared to cuttings that received no hormone or cuttings that were not wounded and dipped in 1000 ppm Dip'N Grow. Growth indices were greater for cuttings that were not wounded and dipped in 1000 ppm Hortus IBA + 500 ppm KNAA compared to cuttings that were not wounded and dipped in 5000 ppm Hortus IBA + 2500 KNAA.

Pomology

Moderator: Mokhles Elsysy
Michigan State University, East Lansing, MI, USA

2:00 PM – 2:15 PM

Controlled Pollination By Bee Exclusion with Alt' Carpo Nets for Organic Gala Production in Michigan State

Mokhles Elsysy*[1]; Sara Serra[2]; Philip Schwallier[1]; Stefano Musacchi[2] and Todd C. Einhorn[1], (1)Michigan State University, (2)Washington State University

Organic apple production is increasing worldwide. Limited availability of chemical products to manage insects and crop load, via thinning, present major barriers to organic apple production. Application of exclusion netting in apple orchard systems demonstrably mitigates abiotic stress and pest pressure. The objective of this experiment was to use exclusion netting to additionally manage the crop load of 'Gala' apple trees by whole-tree enclosure at different stages of bloom. Ten trees per replication were fully enclosed by netting when a pre-defined percentage of open bloom was reached. Treatments included 1) Non-netted, non-thinned control, 2) Non-netted, hand-thinned control, 3) netting at Pink (no flowers open), 3) netting at 20% King Bloom; 4) netting at 40% King Bloom, or 5) netting at 80% King Bloom. Fruit set, yield, PAR, fruit size, seed content, fruit quality attributes and return bloom were assessed. Nets had only a slight effect on fruit set. In 2017, trees completely enclosed in netting at pink had 45% fruit set compared to 65% fruit set of non-netted trees. Further, non-netted control fruit had average seed counts of 4 compared to 1.5 for net treatments. Low seed counts in control fruit was due to frost events. Nets did not significantly affect the number of fruit or yield but there was a tendency for smaller fruit inside of nets. In 2018, we observed a similar response on fruit set. Differences in fruit weight were slightly more pronounced: hand-thinned and non-thinned controls were 145 g and 135 g, respectively, compared to 120 to 130 g inside nets. The number of mature seeds per fruit, however, was markedly higher in 2018 given frost-free conditions. Non-netted trees had ~7.4 seeds per fruit versus ~ 5 for net treatments. The number of non-fertilized seeds was 4.1 for non-netted controls and 6.5 to 7 for net treatments. Despite a high seed content of netted trees, especially those netted at pink, the small orifices of the netting effectively excluded pollinators (including native pollinators). Our data support earlier reports of self-fertility in Gala. We do not dismiss the role of wind pollination to aid 'Gala' self-fertility and the possible contribution of pollen from pollinizer trees in the orchard. The use of exclusion netting to manage crop load does not appear viable in Gala due to self-fertility, but additional research to characterize the effects of netting on thinning of different cultivars and fruit size is warranted.

2:15 PM – 2:30 PM

Controlled Pollination By Bee Exclusion with

Single Row Drape Net in Organic Honeycrisp™ Production in Washington State

Sara Serra*[1]; Mokhles Elsysy[2]; Todd C. Einhorn[2] and Stefano Musacchi[1], (1)Washington State University, (2)Michigan State University

Organic apple production is growing worldwide, and Washington State (WA), as the leading apple producer in the U.S., accounts for approximately 90% of domestic certified organic apples. The main varieties cultivated as organic are Gala and Fuji followed by Golden Delicious, Red Delicious, Granny Smith, Cripps Pink, Braeburn, Honeycrisp™ and other new varieties. The use of overhead nets in the orchards to reduce hail damage is becoming increasingly widespread as protection against other stressors like birds, sunburn and pests. All these factors are important in traditional orchard and are even more relevant in organic production due to the restriction in using synthetic compounds. The use of orchard nets can impact tree physiology altering microclimate and light, vegetative growth, water use and photosynthesis. Moreover, fruit quality is strongly influenced especially in terms of color, physiological disorders and dry matter accumulation. Thinning is one of the most critical issues in apple organic production where few products can be utilized. Thinning strategies in organic production are limited to hand thinning (challenging to apply on large acreage at early fruitlets stage), lime sulfur, other vegetable oil emulsions and mechanical thinning. Less than 20% of fertilized flowers are necessary to guarantee a consistent annual crop. If the full bloom could be avoided, the thinning effort and cost associated with it would be reduced, in particular for Honeycrisp™, a variety that usually sets all fertilized flowers into fruit. The idea to utilize a completely closed drape net system around each orchard row, known in Europe as Alt Carpo' (to exclude *Cydia pomonella*), was tested on organic Honeycrisp™ in WA to exclude bees at different time points throughout bloom. The percentage of king flowers opened to total flower buds available was used as a guideline for deciding when to isolated trees using the drape net system to reduce the pollination (bee exclusion). Different percentages of bloom were tested against three control treatments: one in which trees were closed inside nets before bloom, one without netting (unthinned), and one without netting (normal thinning for commercial Honeycrisp™ orchards) until harvest. Fruit set, yield, number of viable and non-fertilized seeds per apple and instrumental fruit quality parameters were assessed to determine if netting can play an effective role in organic thinning as a physical barrier for pollinators.

Specified Source(s) of Funding: NONE

2:30 PM – 2:45 PM

New Potential Pollinizers for Modern Apple Orchards

Stefan Roeder*; Sara Serra and Stefano Musacchi, Washington State University

Prior to the 1980's, apple cultivars were planted in mixed blocks to ensure cross-pollination. A commonly used planting system during this time was a mixed block design consisting of four rows of 'Red Delicious' and two rows of 'Golden Delicious'. This system allocated a lot of space to the pollinizing cultivar and required orchard management techniques that considered both cultivars at the same time. Since the 1980s, the use of solid blocks with a single cultivar has become more popular because this design saved space and simplified orchard management techniques, such as spraying and harvesting. However, because apples express a gametophytic self-incompatibility system, a compatible pollinizer to replace 'Golden Delicious' was needed. The Manchurian crabapple was a suitable candidate during this time, since it flowered early, bloomed annually, produced viable pollen and was compatible with other main cultivars like 'Red Delicious', 'Fuji' and 'Granny Smith'. Since then, the Manchurian crabapple has become one of the most commonly used pollinizers in the Pacific Northwest. However, during the past decades, new requirements for pollinizers have arisen that were not considered during the crabapple screening in the early 1980s. These new requirements include low disease susceptibility to various quarantine pathogens to avoid trade issues, an upright growth habit to fit in high density plantings, and a long and profuse bloom period that overlaps with new cultivars used in the PWN to achieve cross-pollination. The goal of this research was to identify new crabapples that can potentially be used as pollinizers in modern apple orchards. The candidate crabapples were screened for their bloom intensity and duration, pollen production and viability, return bloom, disease susceptibility, as well as several traits related to growth habit, like internode distance, tree height and width, and total shoot length. Important horticultural traits of some of the genotypes in the trial will be discussed.

Specified Source(s) of Funding: United States Department of Agriculture Technical Assistance for Specialty Crops program, Agreement # 2014-17 activity code: T14RXTSC01

2:45 PM – 3:00 PM

Prior Temperature Influence on Cold Hardiness in Apple Rootstocks 'M.9', 'G.41', 'G.935' and V.6

Renae E. Moran*[1]; Gennaro Fazio[2]; John A. Cline[3] and Bryan J. Peterson[1], (1)University of Maine, (2)USDA-ARS Plant Genetic Resources Unit, (3)Univ. of Guelph

Loss of cold hardiness occurs during unseasonably warm periods during winter and can lead to xylem and cambial tissue damage in trunks and limbs of fruit trees. Apple rootstocks can vary in their ability to maintain cold hardiness during mid-winter exposure to warm temperatures. In the third year of a multi-year study, we measured hardiness in 3 Geneva cultivars and 1 advanced selection from the Vineland series using 2-year-old shoots that were cut from trees. Shoot were placed in buckets of water and exposed to 4, 10 or 21 °C for 2-days. Two-year-old shoot segments were then

cut into 6-cm pieces and exposed under controlled conditions to temperatures ranging from -20 to -38 °C. Some segments were left unfrozen to serve as a control. Hardiness was measured as oxidative browning.
M.9, G.41 and V.6 shoots not exposed to warm temperatures were hardy to -38°C, and G.935 showed partial xylem and cambial injury at -30°C and colder. Prior exposure to 21°C caused loss of xylem hardiness at temperatures of -30°C and colder in M.9, at -35°C and colder in V.6, but no change in G.41 and G.935. Exposure to 21°C caused loss of cambial tissue hardiness at -40°C in G.41 which had mild injury and in V.6 which had severe injury. Cambial hardiness in M.9 and G.935 were unchanged compared to the control. Exposure to 10°C did not cause a measurable loss in hardiness in M.9, G.41 or G.935, but caused an increase in cambial injury in V.6 at -38° C .

Specified Source(s) of Funding: Federal Formula Hatch (NC140)

3:00 PM – 3:15 PM

Nursery Production of Apple Trees Using Root-Pruning Containers Improves Root Quality and Canopy Development in the First Leaf Compared to Bare-Root Trees

Mokhles Elsysy* and Todd C. Einhorn, Michigan State University

Trees account for the majority of expenses when establishing high-density plantings. Trees need to fill space rapidly and produce yields early in the life of the orchard to return the high investment costs. The vast proportion of nursery trees are harvested, stored, and shipped bare-root. These trees are prone to transplant-shock and require additional time to fill orchard space. The objective of this multi-year project is to determine whether root-pruning containers produce apple trees with higher quality root and shoot systems compared to field grown apple trees. We hypothesized that root-pruning containers would promote rapid canopy infill and expedite the return on investment of high-density plantings compared to bare-root trees.

The experiment was conducted in 2017 in two different sites the Michigan State University Horticulture Teaching and Research Center, and Sierra Gold nursery, Yuba City, CA. Three different apple cultivars 'Gala', 'Fuji', and 'Honeycrisp' were bench grafted to M9 'Nic29' rootstock and divided into two production systems: Ellepot containers and field liners. Entire plants, including root systems, were carefully harvested from each production system throughout the growing season. Growth of Ellepot-produced trees was more uniform and total leaf area, average leaf size, and seasonal above-ground dry matter were higher than field grown trees, regardless of scion. Root morphology differed drastically between the two systems. Ellepot-produced trees had markedly higher fine root production and greater root length density compared to field liners. In spring 2018, container and bare-root trees were established in a new orchard using a RCB experimental design. Canopy and root development continued to be significantly greater for containerized trees than field liner/bare root trees throughout 2018 and by the end of the season, containerized trees accrued ~50% to 150% more growth. Roots also continued to show markedly greater fine root production. In subsequent years, flowering, fruiting and orchard productivity will be assessed and related to pre-plant factors to determine if these earlier advantages result in precocity.

Postharvest 4

Moderator: Colin Hart
University of Hawaii at Manoa, Honolulu, HI, USA

2:00 PM – 2:15 PM

Efficacy of Different Formulations of Novel Ethylene Antagonist 1*H*-Cyclopropa[*b*]Naphthalene (NC) on Storage Life and Fruit Quality of Japanese Plum Cultivars

Poe Nandar Kyaw*; Zora Singh; Alan Payne and Vijay Yadav Tokala, Curtin University

The efficacy of different formulations of a new ethylene antagonist, 1*H*-cyclopropa[*b*]naphthalene (NC), on the postharvest physiology and quality of Japanese plum was investigated. Two independent experiments were conducted with Japanese plum cultivars namely 'Tegan Blue' and 'Angeleno'. In both experiments, plum fruit were harvested at commercial maturity and the fruit free from diseases or injuries were subjected to five different formulations i.e., NC fumigation (1 µM) for 18 h and spray treatments on the fruit surface with NC aqueous solution (2 µM) containing 5 % ethanol, NC aqueous solution (2 µM) containing 0.02 % Tween-20, NC aqueous solution (2µM) containing 5 % β-cyclodextrin or NC aqueous solution (2 µM) only, at the room temperature (20±1 °C). The untreated plum fruit were considered as control. In the first experiment, the treated and untreated 'Tegan Blue' plums were stored at ambient temperature (20 ±1 °C, 85±5 % RH) for 10 days and at 0 ± 1 °C (90±5 % RH) for 40-days. In the second experiment, the treated and untreated 'Angeleno' plum fruit were stored at 0 ±1°C (90±5% RH) for 25 and 40 days. In both experiments, the ethylene production (nmol kg^{-1} hr^{-1}), respiration rate (mmol kg^{-1} hr^{-1}), weight loss (%), fruit firmness (N), soluble solid content (SSC) (%), titratable acidity (TA) (%), SSC:TA , individual sugars and organic acids (g kg^{-1}), total phenols (g kg^{-1} GAE), vitamin C (mg kg^{-1}), anthocyanin (g kg^{-1}) and total antioxidant activity (µM kg^{-1} Trolox) were determined at the end of each respective storage periods. The 'Tegan Blue' and 'Angeleno' plum fruit treated with NC regardless of type of formulations exhibited significantly suppressed and delayed climacteric peak of ethylene production, reduced percent weight loss and higher fruit firmness. The levels of SSC, SSC:TA and individual sugars were lower whilst TA and individual organic acids concentrations were higher in NC-treated plums as compared to the control fruit. However, the NC fumigation treatment was significantly more effective in maintaining the studied fruit quality parameters as compared to other NC formulations. The levels of total phenols, vitamin C, anthocyanin and total antioxidant activity were not generally affected with NC treatments. Overall, NC delayed the ripening and maintained the postharvest fruit quality of 'Tegan Blue' and 'Angeleno' plums. The presence of co-solvent or surfactant in preparation of spray solutions enhance the effectiveness of NC application in antagonising action of ethylene.

2:15 PM – 2:30 PM

Elucidating the Mechanism of Pit Formation in Sweet Cherries (*Prunus avium)*

Kelly Richmond*, University of California Davis; Haya Friedman, Agriculture Research Organization- Volcani Center; Bihong Feng, Guangxi University and Elizabeth Mitcham, University of California, Davis

Elucidating the Mechanism of Pit Formation in Sweet Cherries (*Prunus avium)*

Sweet cherries are a high value crop that brings high returns to growers. Pitting is a condition that affects all cherry cultivars, to varying degrees, and reduces the marketability of this high-value crop. Lessening the degree of pitting increases the aesthetic appearance of fruits making more available for marketing. The goal of our research was to understand the underlying mechanisms leading to pit formation and compare sensitive and resistant cultivars. Pit formation emanates from impacts that occur on the tree and after harvest. Understanding the molecular and physiological processes leading to pit formation enables development of knowledge-based treatments to reduce pitting and provide molecular and phenotypic tools for future breeding of low-pitting cultivars. To elucidate the mechanisms behind pitting, a three year study of sweet cherries was conducted in collaboration with the Agricultural Research Organization at the Volcani Center. Six different varieties were included in the project. Two varieties were considered resistant to pitting (Rainier and Bing) while the other four were deemed sensitive (Brooks, Chelan, Coral, and Lapins). For each of the six varieties, cherries were subjected to a controlled impact to induce pitting. The progress of the induced pit development was recorded over the span of one month with fruit stored at 0°C. Cherries from each variety were also collected from local packing houses and observed for a month during storage at 0°C to document development of natural pitting. Pitting severity was judged using a predetermined 1-5 scale. Total and apoplastic calcium content were measured in all varieties at 0 and 3 days after harvest. Additional cherry fruit were dipped in 1% calcium chloride prior to impact to induce pitting. Activity of several enzymes involved in oxidative stress were evaluated in one resistant variety (Bing) and one susceptible variety (Brooks). Enzyme activity was measured at 0, 1, and 7 days after harvest on one group of fruit that was impacted and a separate group that was not impacted. All calcium and enzyme assessments were evaluated in conjunction with pitting to relate pitting severity to these factors.

Specified Source(s) of Funding: US-Israel Binational Agricultural Research and Development Fund (BARD)

2:30 PM – 2:45 PM

Evaluations of Post-Harvest Fruit Quality and Cold-Storage Potential of New Peach Cultivars

Hemant Gohil*, Cooperative Extension of Rutgers University; Joseph Goffreda, Rutgers University - NJAES and Daniel Ward, Rutgers Agricultural Research and Extension Center

Rutgers Tree Fruit Breeding program continues to release new peach varieties, giving growers more options to choose from. Between 2009 and 2016 several new varieties comprising different flesh types were developed after extensive multi-year evaluations at several location in New Jersey, representing different agro-climates. Study comprised new cultivars with firm melting flesh ('Evelynn', 'Tianna', and 'Selena'), partially stony hard flesh ('Gloria') and completely stony hard flesh ('Scarlet Rose') and traditional melting flesh cultivars such as 'Bounty' 'White Lady' and 'Klondike'. Fruit and tree characteristics of these new peach and nectarine varieties are described in detail. We also conducted two or three year study to quantify storage potential of peaches with different flesh types at the post-harvest laboratory at Rutgers Agriculture Research and Extension Center in Bridgeton, NJ. Samples of 20-30 commercially mature, were evaluated at time of harvest, and every 3-4 days, up to three weeks. We evaluated multiple harvest dates for the most cultivars. Fruit flesh firmness, mass, diameter, background color, total soluble solids, and total titratable acidity were measured at each evaluation time. Firm and partially stony hard flesh type peach cultivars soften more slowly than traditionally melting flesh cultivars in the cold storage and to a large extent during room temperature shelf-storage – providing more flexibility to retailers and consumers.

Specified Source(s) of Funding: New Jersey Peach Promotion Council

2:45 PM – 3:00 PM

Phenolic Phytochemicals and Antioxidant Activity Among European, Asian and American−Hybrid Plums

Hye Weon Hwang*; Barbara Cole; Angela Myracle; Raymond C Fort Jr. and Renae E. Moran, University of Maine

Anthocyanins and hydroxycinnamic acids (HCAs) were identified and quantified by HPLC–DAD/MS in 4 to 7 cultivars over three years and at 2 stages of maturity in 2 years. Total phenolic (TP) concentration was measured by the Folin−Ciocalteu method and antioxidant activity (AOA) by DPPH assay. Anthocyanin concentration was highly variable among cultivars, and less variable with stage of maturity and among the three years of testing. Increase in anthocyanin concentration with advance in maturity was generally small in most cultivars, but substantial in 'Methley' and 'Obilnya' which had higher concentration than most other cultivars. 'Abundance', 'Toka' and 'Castleton' had two types of anthocyanins, predominantly cyanidin-glucoside and lower concentrations cyanidin-rutinoside, whereas, in 'Obilnya' and 'Vanier', cyanidin-rutinoside was the predominant anthocyanin. The two cultivars derived from *P. ceracifera*, 'Methley' and 'Obilnya', had cyanidin-galactoside in addition to the other two anthocyanins. The *P. americana*-hybrid plum, 'Kahinta' had only cyanidin-glucoside as did 'Superior'. Concentration of HCA's was greater in European than in Asian and American-hybrid plums, except for 'Toka' which also had a high concentration. Large year-to-year variation in HCA occurred in some cultivars, whereas, variation due to advanced maturity was small. American hybrids displayed greater TP and AOA than European plums, and similar AOA as Asian plums. Although TP was greater in 2015 than in 2016, the curvilinear relationship between TP and AOA was similar in both years.

Specified Source(s) of Funding: Maine Department of Agriculture

3:00 PM – 3:15 PM

Understanding Impacts of Relative Humidity and Temperature of Storage on Walnut Quality

Erin Claire Adkison*, University of California Davis and Elizabeth Mitcham, University of California, Davis

California walnut production is increasing and consumers recognize the health benefits of including walnuts in their diets. With an increase in supply and demand, the walnut industry must enhance the marketability of their product and better understand factors contributing to oxidation, as prolonged storage of walnut kernels can lead to rancidity and off flavor development. To measure rancidity in their product, the walnut industry currently analyzes peroxide values and free fatty acids of oil pressed from the walnut kernels. These measurements are difficult to assess and don't necessarily correspond to the amount of rancidity nor sensory perception of rancidity, thus a better indicator of walnut rancidity development is necessary for the success of the walnut industry. To understand the role of storage in lipid oxidation, we completed a shelf-life study of California walnuts. Walnuts of the Chandler variety were stored at 5°C and 15°C and at 40% and 60% relative humidity for 12 months. Every three months, walnuts were cracked and analyzed for color, water activity, and moisture content. Walnut oil was extracted and analyzed for peroxide values and free fatty acids. A consumer sensory analysis was completed to determine if off flavors were discernable to untrained consumers. All of these parameters were compared to hexanal, a volatile byproduct of lipid oxidation, that was quantified using gas chromatography and solid phase micro extraction. Storage at 5°C was able to retard hexanal formation for 12 months. Peroxide values were higher at 15°C at each time point and increased at a faster rate over time than walnuts stored at 5°C. Relative humidity of storage did not impact peroxide values, as it is a measure of oxidative rancidity. However, free fatty acid content, a measure of hydrolytic rancidity, was higher at 60% relative humidity compared to 40% relative humidity for both temperatures. Walnuts stored at 5°C had lower amounts of hexanal, free fatty acids, and peroxide values than walnuts stored at 15°C after just three months. Storage using oxygen absorbing sachets also retarded formation of these oxidation byproducts. Consumers disliked or were indifferent to walnuts stored at higher temperatures after 12 months of storage. These findings were communicated to walnut storage operators to stress the importance of temperature management in walnut storage for improved quality.

Specified Source(s) of Funding: California Walnut Board Grades and Standards Committee

3:15 PM – 3:30 PM

The Evaluation of Natural and Artificial Drying Systems in Hawaii and Their Effects on Cacao Bean and Chocolate Quality

Colin Hart*, University of Hawaii at Manoa

This study examined the drying behavior of fermented cacao (*Theobroma cacao*) beans subjected to three different drying systems: sun drying, mechanical oven drying, and dehumidification drying. Multiple treatments that included factors such as location, drying intervals, and temperature were conducted within these systems. Sun drying treatments were conducted at four different sites on Hawaii Island to represent the diverse range of environmental conditions. Sites included: Papaikou, and Pepeekeo, which characterize areas with high rainfall and relative humidity, as well as in Kainaliu, and Kawaihae, which receive lower rainfall and relative humidity. Mechanical oven drying, and dehumidification drying were both done indoors in Hilo. Treatments for each drying system included both constant and intermittent cycles. For sun drying, this entailed subjecting one sample to full sunlight all day, and another sample to a standard drying protocol (3 hours of drying the first day, 4 hours the second day, 6 hours the third day, and full sun everyday thereafter until the beans reached a moisture value of 7-7.5% wb. Treatments for oven drying were done at 57°C, and included three separate intervals: 1) constant drying, 2) standard drying, and 3) using an oven drying protocol developed in Trinidad (drying for 2 hours with a rest period of 22 hours). Dehumidification drying was done at a constant rate (drying at 30% relative humidity) and using a step-down approach (drying at a starting point of 65% RH, and decreasing in 10% increments every 24 hr. until beans reached 7-7.5 % wb). Moisture content was measured twice daily throughout the drying period. Color attributes, and pH were measured before and after drying. Bean samples from each treatment were sent to Dandelion Chocolate Company, Guittard Chocolate, and Seguine Cacao Cocoa & Chocolate

An asterisk (*) in front of a name indicates the presenting author.

Advisors to be processed into chocolate and subjected to sensory evaluation. There were significant differences in average drying rates between treatments, with sun drying in Papaikou taking the longest amount of time to dry, and oven drying constant, which took the least amount of time, at rates of 17.9 and 2.9 days respectively. Initial moisture content of beans averaged at 54.9% wb. Average starting pH for testa and cotyledon were 4.54 and 4.7. Average end pH for testa and cotyledon differed significantly between treatments. Results from sensory evaluations of both liquor and chocolate showed differences between treatments, with oven drying standard scoring the highest in terms of overall flavor.

3:30 PM – 3:45 PM

Postharvest Behaviour of Partenocarpic Mango Fruit "Ataulfo", Previously Refrigerated

Joel Corrales-García Sr.*[1]; Perla Andrea gonzález-Carrillo[2] and Maria T. Colinas-Leon[2], (1)Universidad Autonoma de Chapingo, (2)Universidad Autónoma Chapingo

Mexico is one of the main worldwide exporters of mango, mainly from the cultivar 'Ataulfo'. However, an important limitation of this cultivar is the presence of a large number of small fruits (parthenocarpic) that lack commercial value in the export market. Although these small fruits are commercialized with some success in the Mexican domestic market; it would be desirable to develop its commercialization in the export market, which is a challenge due to the fact that it is more perishable than non-parthenocarpic fruit. On the other hand, the physiological response to cold storage and to a more technified postharvest handling of this type of mango is unknown. In view of the lack of information in this regard, the objective of this study was to determine the postharvest behaviour of parthenocarpic mango fruits under two storage conditions, at room temperature (20 °C, 51 % RH) and at room temperature after cold storage (10 ± 2 °C, 94% RH) for 1, 2 and 3 weeks.

The research was carried out with fruits from the main regions producing mango "Ataulfo" in Mexico (Chiapas and Nayarit) to compare the pattern of respiration, weight loss, total soluble solids (° Brix), titratable acidity, total and reducing sugars. pH, firmness, skin color, pulp / fruit weight ratio, chilling injury and visual evaluation. The fruits of Chiapas and Nayarit used as a the control showed the typical climacteric pattern, with maximum respiration rate at day eight after harvest, with 90.2 and 122.7 mL CO_2 $kg^{-1}h^{-1}$ and weight losses of 18.4 and 31.7 %, respectively. The fruits from Nayarit and Chiapas showed chilling injury symptoms only after two and three weeks of refrigeration, respectively. The symptoms observed were high percentages of acidity and of anthracnose.

Key words: Respiration rate, weight loss, TSS, *Mangifera indica* L., chilling injury, mango child, titratable acidity, total and reducing sugars, pH, firmness, color.

Specified Source(s) of Funding: Universidad Autónoma Chapingo

Teaching Methods 2

Moderator: A. James Downer
University of California Cooperative Extension, Ventura, CA, USA

2:00 PM – 2:15 PM

The Effects of Science-Based Social Media on Long-Term Behavioral Changes in Gardeners

A. James Downer*, University of California Cooperative Extension and Linda Chalker-Scott, Washington State University

Social media is prominent in society as various software platforms are now used exclusively on computers and mobile devices. Social media provides educators a way to reach audiences encompassing landscape professionals, other educators (including Master Gardener volunteers), and hobbyists (home gardeners). The "Garden Professors blog" group (https://www.facebook.com/groups/GardenProfessors/) site on Facebook was developed in 2009 and has grown rapidly in membership to over 22,000 members worldwide. The content of the GP group is managed by the "Professors," most of whom hold academic titles at land grant universities or other institutions. A selected group of highly qualified volunteers administer the site to ensure members adhere to a published set of participation guidelines. An extensive collection of current and archived blog posts written by the professors are linked to the site. The group only references peer reviewed papers from horticulture and other relevant plant and soil sciences as evidence to answer questions from members. A survey of Garden Professors members was conducted at the end of 2018 to determine long-term impacts that group membership has had on individual behaviors. The survey collected regional data, age data, frequency of participation, and questions targeted at specific changed behaviors of interest to the professors. Participants were categorized by interest level: professional; education (formal); education (informal) and personal. Condition changes were measured as changed behaviors (78% responded that they changed their behaviors); including changed functional gardening activities (seven activities surveyed); science based learning activities increased (six activities measured). Professionals were frequent visitors to the GP site (ranging from 377 to 2190 visits per year) rather than occasional or moderate in their visitation. Those who changed their behaviors also downloaded significantly more articles from the GP blog and web pages. Blog readers had significantly more (95% confidence interval) improved garden activities and increased science-based learning activities than non-blog readers. Other significant outcomes were that 84% of those that indicated changed behaviors now read horticultural literature more critically, and over 10% initiated secondary education as a result of interacting on the GP site.

2:15 PM – 2:30 PM

The Sustainable Lettuce Competition: An Online Experiential Learning Activity for Teaching the Scientific Method and Sustainability Tradeoffs

Sam E. Wortman*, University of Nebraska - Lincoln

Students studying horticulture typically desire hands-on, experiential learning opportunities, and yet many of these students are enrolled in online classes or degree programs. Thus, the challenge as an online horticulture instructor is to develop experiential learning opportunities for the online environment. Plants, Landscapes, and the Environment is a new introductory course at the University of Nebraska with an online audience of 50 to 75 students each semester. My goal was to develop an experiential learning activity in this course that would increase student confidence in and knowledge about: 1) sustainability tradeoffs in crop production systems, 2) the scientific method, and 3) data analysis and interpretation. To accomplish this goal, I created the Sustainable Lettuce Competition where online students work in teams to make evidence-based management decisions for a greenhouse lettuce crop and compete with their peers (and instructor) to achieve the best balance of productivity, input use efficiency, and profitability. The suite of management choices for each team constitute one treatment in a virtual cropping systems experiment (with instructor choices serving as the best management practice control) that is carried out on campus by the instructors. Students receive weekly video and photo updates, which provide engaged opportunities to teach about the scientific method, crop production, and unique biological phenomena, all under the guise and spirit of the competition. At the end of the experiment, students receive harvest weight data for every lettuce plant across all teams, and use this data to calculate sustainability metrics, create and interpret figures to test their original hypotheses about each management choice, and ultimately crown a Sustainable Lettuce Champion. Learning outcomes for the inaugural Sustainable Lettuce Competition were measured by student performance on the assignment and a survey of students' perceptions of their learning. Students correctly calculated 84% of means and standard errors for sustainability metrics, and 90% of students successfully interpreted that data to identify the teams with the most sustainable management approach. In the learning outcome survey, 83% of students agreed that the competition increased their knowledge about sustainability tradeoffs in crop production systems. Overall, the Sustainable Lettuce Competition was fun for students (and the instructor), promoted regular interaction among peers and the instructor, and most importantly, results suggest it successfully increased knowledge of the scientific method, data analysis and interpretation, and sustainability tradeoffs in agriculture.

2:30 PM – 2:45 PM

Creating a Hybrid, Hands-on Course in Indoor Cultivation for Undergraduates

William Sciarappa*; Albert Ayeni; AJ Both; Xenia Morin and David Specca, Rutgers University - NJAES

Aeroponics, hydroponics and geoponics are innovative and increasingly significant indoor crop cultivation technologies that offer students attractive career opportunities. A team of Rutgers University faculty from different departments developed an educational philosophy, experiential syllabus and learning goals for a new undergraduate course entitled Innovations in Indoor Cultivation of High Value Crops. This 4-credit Junior-Senior class was offered in 2017 and 2018 as a hybrid, student-centered format with two days of 3-hour classes and weekly on-line video modules, remote quizzes, weekly assignments and interactive chatrooms thru the Canvas learning system. Our teaching methods utilized peer-to-peer learning, problem-solving, teamwork and independent study. Key horticultural and entrepreneurial topics were specialty crop cultivation, medicinal crop culture, market demographics, pest management, harvesting, packaging, marketing and greenhouse maintenance and operations. After viewing vetted, on-line greenhouse videos; live presentations were provided by our instructor team of a greenhouse engineer, extension agent, horticulturalists, and expert guest speakers. Students dialoged among themselves to develop a production plan, choose crop species and learn a diversity of controlled environment growth systems to measure and compare horticultural properties. Our NJAES Research and Floriculture greenhouse facilities were used for hands-on learning with crop cultivation systems which included small aeroponic units and hydroponic mini-pod units for proof of concept. Other systems included commercial units such as bato-buckets, benches for container production, and hydroponic units including a student-built floating raft system, vertical towers and a nutrient film technique system (NFT). The students composed production, business and marketing plans and compared these systems in terms of research, educational demonstration and agri-business feasibility. Mid-semester reports of individual or team project data were presented to the class as well as final powerpoint reports including graphical analysis, digital photography and conclusions. Data included harvest fresh weight, root-shoot lengths, color and plant structure. Teams of 2-3 students planted replications of Rutgers Basil and Scarlet Lettuce, kale and several other leafy greens, herbs and vegetables. They maintained individual systems and worked collaboratively online to compile/compare results for each crop. The grading process emphasized participation = 30% based on in-class contributions and documented on-line time, assignments = 20%, two on-line tests = 20% and final exam = 30% based on their individual reports and team's PowerPoint presentation. Student teaching evaluations and comments were highly positive in terms of instructional quality, knowledge acquired, career confidence increase, and team/technical skills gained. After course completion, several students acquired employment in indoor growing operations.

An asterisk (*) in front of a name indicates the presenting author.

Specified Source(s) of Funding: Rutgers University Departments of Plant Biology, Engineering and Agriculture & Natural Resources

2:45 PM – 3:00 PM

Greenhouse Management Workshop for K-12 Educators to Integrate Controlled Environment Agriculture and STEM to the School Curriculum.

Uttara Chandani Samarakoon[*1]; Peter Ling[1]; Laura Grimm[2] and Brian Gwin[3], (1)The Ohio State University, (2)Dalton City School, (3)Ohio State University

Ohio State University Agricultural Technical Institute (ATI) offers an associate degree in greenhouse and nursery management. Many local schools in Ohio have acquired greenhouses, however, without the competence in managing the greenhouses it is difficult to utilize the greenhouses in classroom activities. While the K-12 teachers were inquiring about taking regular courses offered at ATI, conflicting schedules prevented them from attending during school year. In 2018, a survey was sent to local schools in Ohio to evaluate the interest in a greenhouse management workshop among teachers. Content, timing, length of the workshop was determined based on the survey results from 63 respondents across Ohio. A one-day workshop in "Basics of the greenhouse environment" was organized and maximum registration of 30 was reached one month before the deadline. A survey was done at the time of registration to determine years of teaching experience, subject, grades, availability of a greenhouse in school, previous growing experience, and topics for the workshop. Twelve out of thirty registrants were teaching non-agriculture classes and eleven have never done any greenhouse growing. Therefore, the workshop content covered greenhouse basics including environment control, greenhouse production cycle, plant propagation, fertilizer management and lesson planning. The broad range of subject areas of the participants was utilized during the lesson planning session to develop relevant class activities. Post workshop survey was positive with an overall rating of 4.5 out of 5, and the teachers requested additional workshops. The workshops helped K-12 teachers to acquire skills in crop production and technology in greenhouses and enabled them to add relevant plant and technology-based activities to the curriculum.

3:00 PM – 3:15 PM

Reverse Crossword Puzzle Assignments for Teaching Greenhouse Terminology

Jacob D. Schwab[*] and Kimberly A. Williams, Kansas State University

Crossword puzzle assignments are well-suited to aid student learning of discipline-specific terminology. During fall 2015 (n=30) and 2016 (n=39), students in the *Greenhouse Operations Management* course at Kansas State University either solved (S) or created (C) crossword puzzles about greenhouse structural terminology and hydroponics terminology. Students were divided into two groups and each experienced both types of puzzle assignments; however, the order in which the groups received the types of puzzle assignments was reversed. Pre- and post-surveys and exam question scores allowed for comparison of student perception about the assignments and knowledge gained. Student confidence about their knowledge of terminology increased after completing the assignment. There was no difference in exam question scores between the groups. No significant difference in exam question scores occurred between the two types of assignment, suggesting that neither crossword puzzle assignment type offered any advantage.

3:15 PM – 3:30 PM

Using Text Mining to Gauge Student Perception and Content Retention in a Protected Agriculture Course

Gerardo H. Nunez[*], University of Florida

Classic student perception metrics, like surveys and course evaluations, offer limited insight into student content retention and student perception of individual course elements. Recently-developed algorithms facilitate analysis of text data, but their application to education research is still limited. This study used text mining and sentiment analysis to gauge student perception and content retention in a protected agriculture course. Students participated in seven different faculty-led hands-on activities. After each activity, students submitted a short essay summarizing their experience. Student submissions were de-identified and reformatted. Then, word frequencies, lexical depth, lexical density, and sentiment analysis were extracted from the text using the emotion and opinion lexica. Student essays included terms associated with joy, trust, surprise, disgust, and fear, but not sadness. "Exciting" was the most common word related to positive sentiments throughout the course, while "difficult" was the most common word related to negative sentiments. "Learned", "experience", "activity", "plants", and "protected agriculture" were present at similar frequencies in all essays. Mean sentiment scores were greater than +2.0 in all activities, suggesting that hands-on activities had a positive impact on student experience. Essay lexical depth and density increased over time, suggesting that students incorporated technical terminology to their horticulture practice. This was one of the expected student learning outcomes for the course. Altogether, text mining student essays provided insight into student perception and content retention in the course.

3:30 PM – 3:45 PM

Soap: A Diagnostic Technique

Kerrie B. Badertscher[*], Otoke Horticulture LLC

In the 1970s, diagnostics provided various difficulties in the medical world. At that time, charting was handwritten, computers and diagnostic tools were yet to be developed.

During this time, Lawrence Weed, MD developed a tool called SOAP giving the medical team rigor, structure and a way for consistent communication. SOAP rep represents **S**ubjective, **O**bjective, **A**ssessment and **P**lan. Horticulture diagnostics may also be challenging. SOAP provides scouting reports leading to increased positive and consistent production. Revamping this technique for horticulture was first implemented approximately twenty (20) years ago. In 2018, GIE Media (Cannabis Business Times) published an article of the use of this tool and is linked for readers to use. Attendees will be offered SOAP templates for use.

Specified Source(s) of Funding: Otoke Horticulture, LLC

Vegetable Crops Management 4

Moderator: Ravneet K Sandhu
GCREC-University of Florida, Wimauma, FL, USA

2:00 PM – 2:15 PM

Management of Relay-Cropped Strawberry, Pepper, Eggplant, and Cantaloupe to Maximize Yield and Economic Return

Ravneet K Sandhu*, GCREC-University of Florida

Introduction: Strawberry growers in the Southeast USA face rising production costs combined with competition from foreign markets and low commodity prices. These challenges significantly impact the growers that rely solely on the strawberry crop. Relay cropping is a potential tool to face this challenge i.e. planting a vegetable crop on the same bed before strawberry crop termination. It enables continued berry harvest while the new vegetable transplants establish. The benefits of relay cropping include lower crop loss risk and high profits.

Purpose: The objective of the research was to determine the competition between Strawberry and the secondary crops (eggplant, cantaloupe, pepper) and to optimize the planting date of secondary crops.

Materials and Methods: Relay cropping of strawberry (Radiance™) with secondary crops was conducted in fall 2016-17 and 2017-18 at GCREC, Balm, FL. The strawberries were planted in September, and the secondary crops were transplanted on the beds with strawberry plants and as sole crops (controls) at five different dates (Jan 4, Jan 18, Feb 1, Feb 15 and Mar 1). Data on yield and height of strawberries and secondary crops was collected.

Results: Sole crops of eggplants and peppers, and early to mid-planting dates of these secondary crops with strawberries resulted in higher yields ($p<0.05$). However, the interaction between two factors (relay cropping with strawberry and date of planting) was not significant for both the crops. In the case of cantaloupes, no significant effect of relay-cropping or date of planting was observed on the yield of cantaloupes($p>0.05$). Height of eggplants and peppers planted alone was higher than the ones planted with strawberries.

In conclusion, it is beneficial to relay crop strawberries with vegetables. The early to mid-planting dates (Jan 4 to Feb1) are optimum dates for planting secondary crops (peppers and eggplants) on the beds with strawberries.

Specified Source(s) of Funding: self

2:15 PM – 2:30 PM

Using Biostimulants for Improving Tomato Productivity in Florida

Guodong David Liu* and Muhammad Adnan Shahid, University of Florida

A pot study was conducted to investigate the effects of individual biostimulants on tomato (cv. 'Phoenix') growth and yield in greenhouse in fall 2017. Six different biostimulants: CP_1, CP_2, BS, CP_2+BS, Competitor, and Water (control) were respectively foliar-applied at three different stages: pre-bloom, fruit setting and color change. A control (only water sprayed) was paralleled. The contents of Ca, K, Mg and P in leaves and roots were also determined. Plants treated with biostimulants improved the levels of Ca, K, Mg and P compared to those treated with water only. Competitor and CP_2+BS among the six significantly increased yield, plant dry biomass (PDB), plant height, stem diameter, leaf greenness (SPAD reading), photosynthetic rate (Pn), relative water content (RWC), nitrate level in petiole sap, and fruit quality (citric acid, malic acid, tartaric acid, soluble solid concentration and fruit firmness). In addition, enzymatic activities of nitrate reductase (NR) and nitrite reductase (NiR) were increased by the biostimulants. Competitor and CP_2+BS showed the greatest augmentation in plant biomass, plant height, stem diameter, leaf greenness, Pn, RWC, nitrate level in petiole sap, fruit yield and quality. NR, NiR, Ca, K, Mg and P showed a similar trend. Application of Competitor or CP_2+BS may potentially become a BMP tool for tomato production but more trials are needed for large scale field demonstration.

Specified Source(s) of Funding: SWFWMD

2:30 PM – 2:45 PM

Effect of Biostimulant and Fertilizer Application Rates on Growth, Yield, and Quality of Lettuce and Pepper Under Greenhouse Conditions

Moriah Bilenky* and Ajay Nair, Iowa State University

Many biostimulants (humic substances, protein hydrolysates, chitosan, beneficial fungi, and bacteria) are being manufactured and sold with claims such as increased growth, yield and quality, and increased tolerance to stress. Although many of the products that make up biostimulants are sought after by sustainable and organic growers, research on commercial biostimulants is minimal and results are often varied depending on the type of biostimulant, time of application, and even species and cultivar under study. Even less is known about the use of biostimulants categorized under beneficial fungi and beneficial bacteria.

The objectives of this study were to assess the growth and quality of bell pepper (*Capsicum annum* 'Ace') and lettuce (*Lactuca sativa* 'Magenta'), grown in soil-less medium under greenhouse conditions, using six commercial biostimulants (beneficial fungi and bacteria) in combination with two rates of fertilizer (200 and 100 ppm N for pepper and 150 and 75 ppm N for lettuce). Biostimulant products included Bioyield®, Environoc 401®, Mycoapply®, Rootshield®, Select®, and Spectrum + Myco®). The experimental design was a split plot design with fertilizer as the main plot factor and biostimulant the sub plot factor. Plants were grown until horticultural maturity and data was collected, both, at the end of the transplant production phase and at horticultural maturity. Pepper plants receiving the 200 ppm N had significantly higher biomass, height, and stem diameter than those receiving the 100 ppm N at the end of the study. Treatments Bioyield®, Spectrum + Myco®, and Rootshield® resulted in significantly taller pepper plants than the control at the end of the study. Select® had significantly higher average yield/plant than the control treatment. Lettuce receiving the Spectrum treatment had significantly longer roots at transplant stage than the control. The 75 ppm N resulted in significantly longer roots of lettuce transplants and more marketable lettuce heads at the conclusion of the study as compared to the 150 ppm N.

Bioyield®, Rootshield®, and Spectrum + Myco® have the potential to enhance transplant health and crop growth in pepper and lettuce production but continued research is needed on the use of biostimulants in open-field conditions and in combination with different crops and cultivars to determine best uses for vegetable growers.

2:45 PM – 3:00 PM

Challenges in Expanding Broccoli Production in Delaware

Gordon C Johnson* and Emmalea Garver Ernest, University of Delaware

In an effort to diversify, Delaware growers are seeking to expand broccoli production in the state. Delaware is located in the southern portion of the Mid-Atlantic region and with a changing climate, much of the state is experiencing warmer fall weather conditions and more variable spring weather. At the same time, there has been an effort to breed more heat tolerant broccoli varieties for Eastern U.S. production. The objective of this 2-year study was to evaluate available commercial broccoli varieties, expecially those with heat tolerance, for late spring, late summer, and fall harvests in high density plantings under Delaware conditions. In 2017 there were 22 varieties in the 2 spring trials. Seeds of each variety were planted in 72 cell trays in the greenhouse on February 22 and March 8, 2017. Plants were transplanted to the field on April 3 for planting 1 and April 17 for planting 2. The soil was a Hammonton loamy sand. Plots were 7' long with 4 rows wide with 1' between rows and 1' between plants (28 plants). The experimental design was a randomized complete block with 4 replications. Eastern Crown had the highest marketable yield with 467 boxes per acre and 9 % cull. Both Luna and Sakata 6316 also yielded over 400 boxes per acre (452 and 429 respecively). Yields of other varieties tested were below 400 boxes per acre in trial 1. In the April 17 planting, Millenium significantly outyielded all varieties with 641 boxes per acre and 0 percent culls. Other varieties yielding over 400 boxes per acre were Eastern Crown, Emerald Crown, and Sakata 6316 (488, 423, and 406 respectively). Iron Man, Gypsy, Everest, Emerald Jewel, Emerald Crown, and Diplomat had the highest ratings for head evenness. In Fall of 2017 broccoli varieties were transplanted on July 27 and August 16. These trials experienced severe disease conditions (Alternaria) and commercial yields were not obtained. Disease ratings indicated that most varieties were susceptible but Lieutenant and Burney had significantly more marketable heads than other varieties. in 2018 there were 23 varieties in three spring and two fall trials. Tansplanting dates were April 3, April 16, and April 30. Spring weather conditions were extremely variable and yields were low. In the early April planting best yielders were Green Gold and Diamante (269 and 261 boxes per acre respectively). In the Mid-April planting, best yielding varieties were Millennium and Eastern Crown but yields were very low and marketable heads were 34.8% and 29.5% respectively. In the late April planting top yielders, Bejo 3019 and Luna, produced 215 and 201 boxes per acre respecively. For the summer planting varieties were transplanted on July 30 and August 20 2018. The July 30 planting experienced high temperature conditions during early September and also had severe disease pressure (black rot, Alternaria). No commercial yields were obtained. Many varieties did well in the August 20 planting. Diamante, SVBL 2036, Eastern Crown, Emerald Crown, Hydra, Virgo, Diplomat and Lieutenant all had commercial level yields above 400 boxes per acre. These studies indicated that variable weather conditions (heat, heavy rainfall) and diseases can limit the expansion of broccoli growing seasons in Delaware.

3:00 PM – 3:15 PM

Gold Nanoparticles Enhances Seed Germination, Growth and Yield of Onion (*Allium cepa* L.)

Pratibha Acharya*[1]; G.K. Jayaprakasha[1]; Kevin Crosby[1]; John Jifon[2] and Bhimanagouda S. Patil[1], (1)Texas A&M University, (2)Texas A&M AgriLife Research Center

Nanotechnology is a rapidly expanding component of sustainable precision agriculture that promises to revolutionize food production. Recently, biocompatible nanoparticles (NPs) have been explored to enhance seed vigor, germination, stand establishment and productivity. In this study, NPs were synthesized as nanopriming agents using the plant extracts. Nanoemulsions were prepared from turmeric and citrus seed oil using a low energy method based on spontaneous emulsification. Silver and gold nanoparticles were synthesized using onion extracts and characterized by using ultraviolet-visible spectroscopy, dynamic light scattering techniques, and x-ray diffraction procedure. Results showed the successful synthesis of NPs capped with phytochemicals present in the onion extract. These phytochemical capped NPs were used in priming naturally aged onion seeds. Internalization studies conducted by instrumental neutron activation analysis, transmission electron microscopy and gas chromatography–mass spectrometry provided evidence that the treated nanoparticles were internalized in onion seeds. The greenhouse studies were conducted to determine emergence test and different growth and yield parameters were assessed in the field at College Station, Uvalde and Weslaco, TX. Enhanced seed germination, emergence, growth and yield were observed in treated seeds compared to unprimed and conventional hydroprimed seeds. Seed treated with gold NPs (AuNPs) at a low dose (5.4 ppm) exhibited significantly higher germination, growth rates and yields in comparison with other treatments.

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3:15 PM – 3:30 PM

Timing and Rate Strategies for Seed Priming on Transplant Production

Joara S. Candian*; Fernanda Souza Krupek; Andre Luiz B.R. da Silva and Timothy W. Coolong, University of Georgia

Osmotic conditioning is commonly used to increase seed germination by growers seeking for heathier transplants. However, studies reported a large variation of seeds emergence among species, crop varieties, and even lots of same crop variety. The objective of this study was to compare the application timing and rate of different priming strategies on kale seeds emergence. Seeds of four kale varieties (Red Russian, Blue Ridge, Siberian, and Green Afro) were treated with water (for 3, 6, 9, and 12 h), polyethylene glycol (PEG6000) (at 0.2, 0.4, 0.6, and 0.8MPa for 4, 8, 12, and 15 h), and Progibb® LV (5,7% a.i.) (at 0.5, 1.0, 1.5, and 2.0 g a.i./L of solution for 15, 30, 45 and 60 min) to induce seeds emergence. Each priming treatment was considered a single experiment, and all experiments were randomized in a complete block design (r = 4). Treatments were applied at 70 °F and seeds were planted in a greenhouse with temperature varying between 65 and 90 °F. Emergence speed index (ESI) and total emergence (TE) were evaluated during 14 days, and number of leaves (NL), shoot height (SH), root length (RL) and dry matter (DM) after 21 days. Treatments were applied based on the imbibition curve, and kale seeds germinated after 17 h of imbibition. Variety effect was observed on most the response variables, in which Siberian, Blue Ridge, and Red Russian had the highest TE, ESI, and SH/RL respectively, regardless of priming. There was a significant interaction between variety and the Progibb® and PEG6000 rates on ESI and TE. A high ESI (3.89) was obtained on the Green Afro when PEG6000 was applied at a rate of 0.6MPa and Progibb® at a rate of 0.5 g a.i./L. Green Afro's TE decreased by 10.5 and 9.4% when Progibb® rates increased from 0.5 to 1.5 and 2.0 g a.i./L, respectively. Similarly, maximum TE values of 90.9 and 89.4% were obtained with the application of PEG at 0.6MPa or when imbibition was carried out for 12 h, respectively. Overall, the products evaluated in this study had similar effect on total emergence and emergence speed index, however, crop variety should be considered on to improve seed vigor.

3:30 PM – 3:45 PM

Grafted Plants and Microbe-Containing Crop Biostimulants: Can They Improve the Yield of a Strip-till Tomato System?

Nicole Wright[1]; Sonia Walker[2]; Mark Spigos[3] and Matthew D. Kleinhenz*[2], (1)The Ohio State University, (2)The Ohio State University-OARDC, (3)The Ohio State Univ., OH Agricultural Res and Dev Center

Strip-till vegetable systems offer benefits unavailable from standard ones featuring raised beds topped with plastic mulch. However, so far, comparable or superior yield is not among these benefits as the productivity of standard systems continues to exceed that of reduced or strip-till ones. That said, previous strip-till research did not include grafted plants or microbe-containing crop biostimulants. In separate literatures, grafted plants and biostimulants have been shown to possess characteristics and activities potentially important in strip-till settings when used alone or in combination. Informed by these literatures and preliminary experiments completed 2014-2017, we began documenting grafting (rootstock; RS) and inoculation(ant) effects on the yield and quality of tomato fruit taken from a strip-till system. Individual and potentially additive effects of planting stock and inoculation(ant) remain our focus. Winter wheat sown in Fall-2017 was green-chopped on May 24, 2018, leaving residue approximately 15 cm in height. One day later, a PTO-driven roto-tiller with one pair of tines was used to create 25-cm wide by 15-cm deep strips on 1.8-m centers throughout the field. On May 29, the ten-treatment, double-control, eight-replicate experiment was initiated by setting ungrafted and grafted 'BHN589' plants into the strips at 76 cm intervals, with individual plots containing eight plants of one type and RS and arranged in a randomized complete block design. Estamino, Maxifort, and Submarine RSs were chosen for their reported moderate, high, and low vigor, respectively. All plants in individual selected plots were inoculated by delivering the labeled rate of either iNvigorate (Agrinos) or LC+LT (Lallemand) directly to the soil at the base of each plant as a drench using distilled water as the diluent (inoculation at 2, 4, 6, and 8 weeks after transplanting). Fruit at the blush or more advanced stages of ripening were collected from the center four plants of each plot six times August 8 to September 25 and weighed, sorted, counted, and subsampled for measures of °Brix, pH, and titratable acidity. The experiment was repeated in two

replicates of a standard system established at the same time in the center of the same field; crop drip-fertigation and protection practices were identical throughout the field. The work is being repeated in 2019. In the strip-till system, total cumulative yield was unaffected by inoculation regardless of planting stock but increased eighteen percent by grafting (across all RSs and regardless of inoculation). Also, total cumulative yield correlated with reported values of RS vigor.

Specified Source(s) of Funding: USDA-NIFA ORG and SCRI programs and NCR-SARE

Stone Fruits

Moderator: Laura Hillmann
Michigan State University, East Lansing, USA

3:30 PM – 3:45 PM

Crop Load Reduction in Peach (*Prunus persica* L.): The Effects of Timing and Intensity

Mary K. Sutton*; Anish Malladi and Dario J. Chavez, University of Georgia

Fruit growth is limited early in the growing season by competition among fruit for available resources. By reducing the crop load, competition is lessened, and fruit growth can be maximized. Thinning is a common cultural practice used to remove fruit to reduce competition and potentially achieve larger fruit size and higher yield. The timing and intensity of thinning affects the efficacy of the treatment. The objective of this study was to determine which thinning time and intensity is most appropriate for Georgia peach growers. We evaluated the effects of three thinning times (at bloom, ~40 days after bloom (DAB), ~60 DAB) and two intensities (~15 cm or ~20 cm fruit spacing) for three peach cultivars (CaryMac, Springprince, and Juneprince) in 2017. No significant differences were observed among treatments for final yield, fruit weight, diameters, soluble solids content, nor titratable acidity. A late spring freeze paired with the substantial lack of chill hours in 2017 likely affected the responses seen in these cultivars. The study was repeated in 2018 using earlier thinning times (bloom, ~14 DAB, ~28 DAB) and the same two intensities for three cultivars (CaryMac, Summerflame, and Julyprince). In 2018 adequate chill hours accumulation occurred and Georgia did not experience a late hard freeze. The differences observed among treatments suggested that bloom thinning is not a viable option for Georgia growers and that it may be better to thin later to a higher intensity. In addition, we aimed to develop a model that could predict harvest dates and final fruit size/total yield based on chill hour accumulation, early spring temperatures, and a variety of field-specific parameters. We have observed a significant relationship between growing degree hour accumulation (at 30 days after bloom) and yield per tree. The goal of this model is to provide growers with an idea of what to expect that season and aid in their decision to thin.

Specified Source(s) of Funding: Georgia Department of Agriculture

3:45 PM – 4:00 PM

Do Changes in Irrigation and Fertilization Practices Affect Fruit Yield and Quality of ‘Julyprince’ Peaches in Georgia?

Bruno Casamali*; Marc W. van Iersel and Dario J. Chavez, University of Georgia

In areas where irrigation is needed and water sources are scarce, several studies have assessed the benefits of irrigation or regulated deficit irrigation on peach plant growth, and fruit production and quality. In Georgia, irrigation is not installed and utilized until peach plants are commercially productive (3rdor 4thyear after planting). Until then, plants rely only on rain as their water source. Little research has been done in the past to assess the effects of irrigation on young peach plants in the southeastern US. Additionally, the fertilization rates utilized by the growers were developed decades ago and might need an update in order to keep the production system economically and sustainably viable. The objective of this research was to assess the effects of two irrigation rates (irrigated vs. non-irrigated), two irrigation methods (drip vs. micro-sprinkler irrigation), and four fertilization rates (25%, 50%, 100%, and 200% of the current fertilizer rate) on fruit yield, weight, size, and quality of young peach plants. An orchard of ‘Julyprince’ cultivar grafted onto ‘Guardian™’ rootstock was planted in 2015 (358 plants/hectare) and was utilized for this research. Fruit yield and quality parameters were evaluated in 2017 and 2018 (1stand 2ndharvest seasons). In 2017, fertilizer treatments or irrigation systems did not affect fruit yield; however, irrigated plants had 20% greater yield than non-irrigated plants. Non-irrigated plants displayed a slightly-advanced maturation stage (lower chlorophyll content of the fruit - DA index®) than irrigated plants; and micro-sprinkler irrigated plants had 7% greater total soluble solids (TSS) than drip irrigated plants. No differences were found for fruit weight, fruit diameter, total titratable acidity (TTA), and TSS/TTA ratio. In 2018, no differences in fruit yield were found among fertilizer rates or between irrigation rates; however, sprinkler irrigated plants had a ~90% increase in yield, likely due to an advective freeze that negatively affected the drip-irrigated plants during budbreak. No differences were found for fruit diameter, DA index, and TSS/TTA ratio. Micro-sprinkler irrigated plants had fruits with ~9% greater weight than the drip irrigated plants, and non-irrigated plants had ~5% greater TSS and TTA than irrigated plants. In conclusion, irrigated plants have the potential to have a greater yield than non-irrigated plants especially when succeeding a period of drought. Fertilizer rates can be reduced without negative effects on fruit production. The treatments tested had minor to no effects on the fruit quality parameters.

Specified Source(s) of Funding: Peach Commodity Commis-

sion Grant

4:00 PM – 4:15 PM

An Investigation of Peach Production By the Navajo, Hopi, and Pueblo Native American Tribes

Reagan C. Wytsalucy*, Extension and Brent L Black, Utah State University

Southwest Native American Tribes, such as the Navajo, Hopi, and Pueblo, have grown peaches at least since the early 1600's, making them an important food source. Few isolated peach orchards in remote canyons and mesa shelves are still tended using traditional methods. The purpose of this study was to locate and characterize these plantings in order to understand the genetics of these isolated land races, to determine the conditions under which they are grown, and to document traditional management practices. Seeds were collected from these isolated populations for genetic analysis. Soils, microclimate and water availability were documented for these sites. Live and dead tree core samples were collected with oral histories from Native American elders regarding the crops' management and uses. Preliminary analysis indicates populations from different locations are also isolated genetically. Oral histories of management practices indicate that trees were not pruned or thinned, and only passively irrigated. Dendrochronological analysis confirms the oral histories regarding management. The results of this research will be used to help preserve traditional knowledge that can be utilized to produce and promote this historically and culturally important crop.

Specified Source(s) of Funding: Utah Department of Agriculture and Food

4:15 PM – 4:30 PM

Spray Pollination System to Increase Fruit Set in Sweet Cherry

Katherine C. Taylor* and Matthew Whiting, Washington State University

Sweet cherry (*Prunus avium* L.) is an important cash crop in the United States, where Washington is the principal producer. The value of the 2017 crop exceeded one billion dollars with 81% of production in the Pacific Northwest. A constant challenge for growers is unpredictable fruit set caused by inclement weather during early spring bloom and the disruption of pollination by climate change and colony collapse disorder. A more reliable method to pollinate commercial crops is needed to ensure yield security. Our team at Washington State University has been investigating an alternative pollination system of pollen suspensions applied with electrostatic sprayers. This work is investigating: 1) the potential for commercial artificial pollination and, 2) the variability in sweet cherry pollen performance. In 2018, we conducted field trials in commercial sweet cherry orchards across Washington to examine pollen application rates and timing. The following treatments were applied depending on location: no-spray control, suspension mix-only, 30 grams of pollen per acre by airblast application, and electrostatic applications of 15, 30, and 60 grams of pollen per acre. We collected and analyzed data for percent of flowers open at time of application, fruit set, and yield. To assess pollen performance among cultivars and growing seasons, we collected pollen from ten cultivars at the WSU-Roza research farm in 2017 and 2018 and used germination tests to determine viability. Across treatments in electrostatic field trials, mean fruit set ($n = 351$) ranged from 4% - 53%. Yield data from trials in Finley and Brewster suggested an increase in the pollen treated trees, but was not significant ($P = 0.50$, $P = 0.36$ *respectively*). No treatment effect was observed in the field trials. Our data suggest that application at earlier stages of flowering may have increased efficacy. These trials direct further research in which pollen viability is monitored throughout application. In pollen viability assays, there was variation among cultivars in 2017 ($P = 0.0001$) and 2018 ($P = 0.001$), as well as variation between growing seasons ($P = 0.0001 – 0.40$, *depending on cultivar*). Overall, this research suggests there is potential for electrostatic spray systems to ensure consistent, reliable pollination. Further investigation of cultivar variability, pollen viability, spray rates, and schedules is required to maximize the efficacy of such systems.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

4:30 PM – 4:45 PM

Alternative Ground Cover and Nutrient Management Strategies for Sweet Cherry

Ashley Thompson*, Oregon State University; Lynn Long, Oregon State University Extension Service and David Granatstein, Washington State University

In orchards, ground cover and nutrient management strategies impact soil and tree health. Many sweet cherry orchardists manage weed competition by maintaining a bare herbicide strip in the tree row. Alternative ground cover management strategies, such as mulching can reduce weed competition and improve edaphic properties, such as soil organic matter (OM), cation exchange capacity (CEC), water infiltration, and the availability of certain mineral nutrients. In some instances, mulch applications can also increase fruit yield and tree growth. Despite these benefits, mulch is not widely applied in orchards due to availability and cost. Common orchard nutrient management strategies involve ground or foliar applications of fertilizers based on soil and leaf mineral nutrient analyses. However, there is growing interest in intensive nutrient management programs that assess and correct small changes in plant mineral nutrient status throughout the growing season. Beginning in 2017, we compared the effects of four management systems on cherry yield and quality, plant mineral nutrition, and soil quality in a commercial 'Skeena'/ 'Gisela 6' cherry orchard. Management systems included: (1) Standard orchard management- a bare herbicide strip in the tree row with a standard nutrition program. (2) A single 10 cm application of mulch with a standard nutrition program. (3) A bare herbicide strip with a "bio-intensive" foliar nutrition program. (4) A combination of 10 cm of mulch and the bio-intensive foliar nutrition program. After two years, mulching or bio-intensive nutrient management did not increased cherry yield, fruit size, or soluble solids compared to the bare herbicide strip or the standard nutrition program. Mulching reduced fruit firmness by 6% compared to the bare herbicide strip. Bio-intensive nutrient management increased fruit firmness by 5% compared to the standard nutrition program. Compared to the herbicide strip, mulching reduced water infiltration time by 78% and increased soil OM by 42%. However, mulching did not affect soil active carbon or CEC. The bio-intensive program did not increase soil quality measures compared to the standard nutrition program. These results are consistent with previous research that suggests mulching can enhance soil quality, but may not increase crop yield or quality. Our result suggest that bio-intensive nutrition programs may increase some fruit quality measures, and that a single mulch application can improve soil edaphic properties after two years. However, orchardists that apply mulch should consider adjusting their irrigation regiments to maintain fruit quality.

Specified Source(s) of Funding: NRCS CIG

4:45 PM – 5:00 PM

Non-Yield Measurements Add Value to Rootstock Evaluation for Prune Production

Luke Milliron*[1]; Franz Niederholzer[2]; Richard Buchner[2]; Joseph H Connell[2] and Allan Fulton[2], (1)University of Califiornia Cooperative Extension, (2)University of California Cooperative Extension

Yield is a key measurement of interest in field evaluations of novel rootstocks for tree fruit and nut production. However, key non-yield measurements help differentiate test rootstocks. Replicated and randomized field evaluations have been performed at two sites for novel rootstocks for prune (*Prunus domestica*) production in California's northern Sacramento Valley. Measurements of trunk cross-sectional area and ratings of tree anchorage, rootstock suckering, and tree survival were evaluated at the two prune rootstock trial sites. Phenological monitoring of bloom density and timing at one prune rootstock trial site (2016, 2017 and 2018), as well as midday stem water potential readings with the pressure chamber have been conducted. Trunk cross-sectional area measurements differentiated a significant range in the vigor conferred from the rootstock to the prune (cv. 'Improved French') scion. Survival of prune rootstocks ranged from 97% ('Atlas') to 30% ('Empyrean 2') at one trial site and from 100% ('Atlas', 'Viking' and 'Krymsk 86') to 45% ('HBOK 50') at the second trial site. Higher vigor (trunk-cross sectional area) rootstocks tended to be less water stressed (less negative) at a midday stem water potential pressure chamber reading. 'Krymsk 86' and 'Viking' were among the rootstocks evaluated at two prune trials that had both few rootstock suckers and the least degree of lean. Finally, some consistent year-to-year relative differences in bloom timing by rootstock treatment were evident at the evaluated trial site. Although yield is of key interest to researchers and growers alike, numerous non-yield measurements can help differentiate the merits and disadvantages of evaluated rootstocks. This is particularly the case for non-yield measurements of direct horticultural value to growers.

Specified Source(s) of Funding: Prune Board of California and Almond Board of California

5:00 PM – 5:15 PM

Relative Water Content of *Prunus Cerasus* Reproductive Buds As a Sensitive Proxy for Preanthesis Pistil Growth and Completion of Ecodormancy

Laura Hillmann*[1]; Mokhles Elsysy[1]; Nikki Rothwell[1]; Michael Blanke[2] and Todd C. Einhorn[1], (1)Michigan State University, (2)University of Bonn

Once eco-dormancy is fulfilled, ovaries of tart cherry (*Prunus cerasus* L.) 'Montmorency' flowers steadily lose freeze resistance. The progressive accumulation of heat units advances floral buds development. Floral buds are classified by discrete phenology stages between dormancy and anthesis. Each stage has been associated with a critical survival temperature. Although these phenology stages are distinguishable by visual characteristics, they have not been correlated with actual ovary growth. Further, the early phenology stages between dormancy to first swelling and side green-to-green tip have overlapping visual characteristics and, thus, are not easily discernable. The aims of this research were to phenotype reproductive buds and relate changes in their physical properties with ovary growth and development. A secondary objective was to identify proxies for resumed ovary growth following eco-dormancy. Floral buds were collected several times per week near the end of eco-dormancy until anthesis during two consecutive years of 2017 and 2018. Fresh buds were weighed, imaged and relative water content (RWC) was calculated. Entire pistils were extracted from a subset of fresh floral buds and imaged. Ovary diameter and volume were measured using calibrated image analysis software. Seventy to 100 floral buds were randomly selected from each sample population and frozen in a programmable temperature chamber at a rate of 1.5°C per hour. The lethal temperature (LT_{50}) of flowers was determined by a combination of differential thermal analysis (DTA), between dormancy and first swell and visual assessment (oxidative browning between first swell and anthesis). Between dormancy and green tip, ovary volume increased nearly 5-fold and RWC increased from 50% to 80% for both years. The onset of pistil growth occurred during the transition from bud swell to side green. Concomitantly, ~13°C of hardiness was lost during this period, and the phenology stages showed only little visual difference. Relative water

content was strongly associated with pistil growth and loss of hardiness and served as an objective indicator of bud development. Most of the physiological changes occurred within the first 150 GDD, with relative water content being the most sensitive predictor of developmental change.

Fruit Breeding 2

Moderator: Jason D. Zurn
USDA-ARS NCGR, Corvallis, OR, USA

4:00 PM – 4:15 PM

Performance of Pitaya (*Hylocerus,* Cactaceae) Hybrids Under High Temperature Stress

Eran Raveh[1]; Udi Zurgil[2]; Divya Sravanthi[2]; Lu Shu-Hua[2]; Milena Oliveira[2] and Noemi Tel-Zur[*2], (1)Agricultural Research Center, (2)Ben-Gurion University

Heat stress is a major factor limiting agriculture in drylands. Thus, improving the tolerance of crops to high temperatures or/and introducing new species of high economic value that are intrinsically adapted to extreme conditions could make an important contribution to local economies in drylands. Promising minor crop candidates with high economic value are vine cacti of the genus *Hylocereus* (known as pitaya or dragon fruit). As members of the Cactaceae, these species can grow in poor and marginal soils, and they exhibit a range of specific adaptations to extreme drought conditions. Indeed, pitaya plants show four- to sixfold higher water use efficiencies than other fruit crops grown under similar conditions in the Negev desert of Israel. However, high temperatures damage pitaya plants and drastically reduce – and even inhibit – flowering, thus reducing yields and profitability. Nonetheless, effective breeding and selection may provide the means for expansion of this fruit crop to additional dryland areas the world over. The main objective of this research was thus to study heat tolerance in a group of *Hylocereus* species, including the diploids *H. undatus* and *H. monacanthus*, the tetraploid *H. megalanthus*, and several interspecific-interploid hybrids. Rooted cuttings growing in pots were exposed to daily heat stress (45/35ºC) in growth chambers for eight days, and their performances were compared with those of cuttings growing under control conditions (25/20°C). Cell membrane stability, chlorophyll fluorescence (F_v/F_m), chlorophyll content and acid accumulation decreased in all parental species and hybrids under heat stress, but the magnitude of the damage was lowest in the allotetraploid designated Z-10. Compatible solutes, such as total soluble sugars and proline, accumulated under heat stress in all the studied species and hybrids, with the highest accumulation being observed in the allotetraploid Z-10. Under the high temperature conditions, Z-10 exhibited increased activities of superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX) and glutathione reductase (GR) and significantly higher expression of heat shock proteins, such as *HSP1* and *HSP70*, than the other species and hybrids. Overall, the results presented here show that high temperatures could have significant effects on the physiological status of vine cactus plants and that the allotetraploid Z-10 may be more tolerant to heat stress than its parental lines. Thus, our results suggest that following interspecific hybridization tolerance to high temperatures could be enhanced, a phenomenon that may be attributed to "hybrid vigor" or heterosis, a topic that deserves further investigation in *Hylocereus*.

4:15 PM – 4:30 PM

Utilization of Near-Infrared Spectroscopy for Non-Destructive Prediction of Postharvest Traits in an Apple Breeding Program

Soon Li Teh[*]; Jamie L. Coggins; Sarah Kostick and Kate Evans, Washington State University

In an apple breeding program, development of cultivars with desirable eating quality and postharvest characteristics is of paramount importance. To optimize fruit quality and harvest time of seedling selections, fruits are destructively evaluated during the season. This presents a challenge when young seedling trees do not bear sufficient fruits for destructive sampling. A non-destructive alternative would allow prediction of fruit quality indices regardless of fruit count, and increase selection efficiency. In recent years, near infrared (NIR; λ = 750 – 2500 nm) spectroscopy has garnered interest in the food and agribusiness industries, enabling facile analysis of parameters associated with traditional destructive assessments. Previous reports of NIR use in fruit crops were based mainly on one to two cultivars, instead of the large genetic variability in a typical breeding program. The objective of this study was to evaluate the accuracy of NIR prediction for postharvest traits of 20 selections for routine application in the Washington State University apple breeding program (WABP).

In 2015 and 2016, fruits from 20 advanced seedling selections at three orchard sites were harvested and stored for two months at 2 °C. After storage, fruits were evaluated using destructive analytical tests (dry matter concentration [DMC], soluble solids concentration [SSC], titratable acidity [TA] and firmness) as well as an NIR instrument (Felix F-750). NIR measurements and the corresponding trait values were used to build partial least squares regression models. Subsequently, regression coefficients in a training model were used to predict the trait values of another set (i.e., validation). Deviations in the validation set between the predicted values and the instrumental values were reported as prediction accuracy metrics, such as ratio of prediction to deviation (RPD) and correlation (ρ).

Wide variation in values of the four postharvest traits was observed among the 20 advanced selections across three locations in both years. Although training models failed to build for TA and firmness, reasonably robust training models (R^2 > 0.80) were developed for DMC and SSC in both years. Validation of DMC exhibited high prediction accuracy (RPD > 2.5; ρ > 0.90), while validation of SSC exhibited moderate

An asterisk (*) in front of a name indicates the presenting author.

accuracy (RPD ≈ 1.5; $\rho \approx 0.70$). Current work is underway to: (1) validate within- and between-years sets, (2) assess the accuracy of longitudinal forecasting, and (3) optimize a training model with robust prediction accuracy based on all 20 selections for use in the breeding program.

Specified Source(s) of Funding: WSU Apple Breeding Program

4:30 PM – 4:45 PM

Volatile's Role in Blueberry Flavor: What Compounds Are Responsible for Novel Aromas?

Haley Sater* and Patricio Munoz, University of Florida

To improve fruit quality, it is necessary to understand the volatile composition, and identify which molecules impart favorable aromas. This study focuses on blueberries (*Vaccinium corymbosum*). Individual plants were selected from the University of Florida's breeding nurseries for their aroma and henceforth referred to as aromatics with two objectives First, utilize sensory panels to understand whether consumers are able to detect and how they respond to the unique aromatic volatile trait in aromatic blueberries. Second, identify specific volatiles, found in VAP berries selected for their distinct, aromatic flavor, originally noted in the aromatic cultivars 'Snowchaser' and 'Kestrel'. Results from taste panels indicated that a significant number of panelists could detect a novel flavor or flavors in the aromatic genotypes selected by experts as compared to non-aromatic genotypes. However, VAPs selected were not preferred in terms of 'overall liking' or 'overall flavor liking' by panelists. Volatile analysis from GC-FID quantitation and identification using a GC-MS found 84 volatile compounds among all genotypes surveyed. When volatiles present in aromatic genotypes were compared to non-aromatic genotypes 15 compounds differed significantly in abundance between the two groups. Fourteen of these compounds were found and higher levels in aromatic genotypes and only one, isopentyl acetate was found in a lower quantity in aromatic genotypes. Additionally, the aromatic genotypes had significantly higher levels of soluble solids and higher soluble solids to titratable acid ratios.

4:45 PM – 5:00 PM

Hybrids of *Vaccinium Corymbodendron* Dunal. x *V. Vitis-Idaea* L. As Bridges between Blueberry, Cranberry, and Lingonberry

Mark K. Ehlenfeldt* and James Polashock, USDA-ARS

The blueberry species *V. corymbodendron* of section *Pyxothamnus* has shown value as a potential bridge between taxonomic sections and ploidies in *Vaccinium* when involved as either as a first-generation or second-generation parent. Tetraploid *V. corymbodendron* was hybridized successfully with 2x and 4x section *Cyanococcus* species (blueberry) and 2x section *Vitis-idaea* (lingonberry). Early indications suggest hybridizations with section *Oxycoccus* (cranberry) are also successful. Second generation allotetraploid *V. corymbodendron - V. vitis-idaea* hybrids have hybridized successfully with 4x section *Oxycoccus* (cranberry), 4x section *Cyanococcus* (blueberry), and 2x section *Vitis-idaea* (lingonberry). It appears that these allotetraploid hybrids may allow gene movement among these diverse sections at the 4x level. Further test-crosses are being made to evaluate the range of crossability of 4x *V. corymbodendron* and the *V. corymbodendron* allotetraploids with other taxonomic sections of Ericaceae.

Specified Source(s) of Funding: USDA-ARS

5:00 PM – 5:15 PM

A Global Analysis of Soluble Solids Content in Strawberry

Jason D. Zurn*[1]; Mulusew Fikere[2]; Sujeet Verma[3]; Iraida Amaya[4]; Pilar Muñoz del Rio[4]; José F. Sánchez-Sevilla[4]; Helen Cockerton[5]; Richard J. Harrison[5]; Lise L Mahoney[6]; Thomas M. Davis[6]; James F. Hancock[7]; Chad E. Finn[8]; Megan M. Mathey[9]; Jodi Neal[10]; Hian-Lien Ko[10]; Vance M Whitaker[3]; Craig M. Hardner[2] and Nahla Bassil[1], (1) USDA-ARS NCGR, (2)University of Queensland, (3)University of Florida, (4)Instituto Andaluz de Investigación y Formación Agraria y Pesquera, (5)NIAB EMR, (6)University of New Hampshire, (7)MSU, (8)USDA-ARS HCRU, (9) Spring Meadow Nursery, (10)Department of Agriculture and Fisheries

Strawberry (*Fragaria ×ananassa*) fruit flavor is due to a complex mix of sugars, acids, and aromatic compounds. Consumers tend to prefer sweeter strawberry cultivars. Therefore, sweetness has been an important target trait for breeders. The majority of strawberry soluble solids are sugars, and soluble solids content (SSC) is used as a proxy to determine sweetness. A strong genotype × environment (G × E) interaction has been observed for SSC, causing difficulties when studying the genetics underlying SSC in individual environments. A meta-analysis of multiple environments may provide new insights toward unraveling the genetics underlying SSC. Genotypic and phenotypic data were collected for 3,407 total individuals from seven breeding programs (four in the United States, one from Spain, the United Kingdom, and Australia). Subsets of the individuals were evaluated for SSC in 19 environments. Genotypic information from the 90K and 35K Axiom arrays was reduced to 12,951 high quality single nucleotide polymorphism markers shared by all accessions. Missing data was imputed, linkage disequilibrium was calculated, and a relationship matrix was constructed for all samples. Using this information, multiple G × E models were evaluated for their predictive ability among environments. Results demonstrate how genomic models can be used to predict strawberry SSC in new environments.

Specified Source(s) of Funding: USDA-NIFA SCRI project 'RosBREED: Combining Disease Resistance and Horticultural Quality in New Rosaceous Cultivars' (2014-51181-

22378)

5:15 PM – 5:30 PM

Phenotypic Evaluation of *Vaccinium elliottii* and Southern Highbush Hybrids for Blueberry Breeding

Diego Cabezas*, University of Florida

During the blueberry breeding history, interspecific hybridizations have been widely used as source of novel agronomic traits. A successful example was the development of Southern Highbush Blueberries (SHB) through the hybridization of a US northern adapted highbush species (*Vaccinium corymbosum*) with a native Floridian species (*Vaccinium darrowii*), which resulted in reduction of chilling hours requirement, resistance to diseases, as well as improvement in fruit quality. *Vaccinium elliottii* possesses multiple traits that can benefit the blueberry production in the southern US. Besides the high sugar content and characteristic aroma, this species also presents a short bloom to ripe period, which could positively affect the earliness on new cultivars. Moreover, since the species naturally occurs in the Southeast of US, its introgression into SHB background may also improve adaptation to well drained sandy soils, which could lower the cost of soil amendments for growers. Therefore, the main objective of this study was to identify *V. elliottii* individuals and crossing combinations with SHB showing superior phenotypic performances, with the future ultimate goal of introgressing the favorable traits from *V. elliottii* into SHB cultivars. To this end, two F2 hybrid families were evaluated for four agronomical traits (plant vigor, plant height, disease resistance, and plant survival) and for five fruit quality traits (berry size, firmness, soluble solids content, pH, and titratable acid). Results from fruit quality showed an increase on berry size on F2 hybrids when compared with *V. elliottii*, while a decrease in berry size compared to SHB. The highest levels of soluble solids were found in *V. elliottii* compared with SHB and F2 hybrids. F2 hybrids had a significantly lower acidity (titratable acids) compared with *V. elliottii*, but significantly higher acidity compared to SHB. No significant differences in firmness was found between hybrids and SHB. Results show that in two rounds of crossing the values for economically important traits were compatible between the hybrids and SHB, which suggests that it may be suitable to introgress important traits from *V. elliottii* into SHB without losing important quality traits from SHB

Specified Source(s) of Funding: University of Florida - Blueberry breeding Lab

Thursday, July 25, 2019

Ornamental Plant Breeding 2

Moderator: Lisa Alexander

USDA-ARS, McMinnville, TN, USA

10:30 AM – 10:45 AM

Caladium Breeding and Genetic Research at the University of Florida

Zhanao Deng*, University of Florida

Caladiums are ornamental aroids often grown in containers and in the landscape for their colorful and variably-shaped leaves. For the last seven decades, Florida has been the leading producer of caladium tubers, providing essentially all the tubers used in the world. A public caladium breeding program was initiated in 1976 at the University of Florida/IFAS to satisfy Florida growers' need for new caladium varieties. Since then, hybridization among existing varieties and rigorous selection have resulted in the development and release of more than 30 new cultivars with bright leaf colors, novel coloration patterns, multiple leaf development, and high tuber yield potential. In response to industry needs, the breeding program has included resistance to *Pythium* root rot, *Fusarium* tuber rot and bacterial blight, and tolerance to sunburn injuries as breeding objectives. Towards these objectives, a number of sources of disease resistance have been identified. A number of the released cultivars showed improved resistance to Fusarium tuber rot and tolerance to sunburns. Other breeding approaches including somaclonal variation and ploidy manipulation are being explored. Inheritance studies over the past 15 years have revealed a group of five closely linked loci controlling five important foliar traits (main vein color, leaf spots, blotches, leaf rugosity and lemon green leaf background color) and an independent locus controlling leaf type. Chromosome number variation was founded to be the main cause of high frequency somaclonal variation in caladium. In addition, research revealed a wide range of chromosome number (and nuclear DNA content) variation among caladium species.

Specified Source(s) of Funding: USDA Hatch Project FLA-GCC-005507; Florida caladium growers; Florida Foundation Seed Producers, Inc.

10:45 AM – 11:00 AM

Gladiolus ×Hybridus breeding for Rapid Generation Cycling and Reduced Dormancy

Jaser A Aljaser* and Neil O. Anderson, University of Minnesota

Gladiolus ×hybridus is iconic cut flower in floriculture, producing a geophytic storage organ (corm) used as means of vegetative propagation. Gladiolus corms have deep dormancy and require a cold treatment to break it before flowering in the subsequent year. Gladiolus breeding is aimed to improve floral traits and disease resistance. However, the life cycle of gladiolus is typically 3-5 years from seed to flower; this long juvenile period slows the rate of progress. Our research aims to reduce juvenility and produce an annualized perennial for seed propagation. More than 20 years of selection for early seed germination and earlier flowering produced a cycle 1 flowering gladiolus which resulted in flowering from seed in the first year. The number of weeks to flower is ≤43 weeks from seed with 1-5 florets/stalk. The objective of this study was to determine the heritability of cycle 1 flowering. Recurrent selection was used for crossing two cycle 1 parents, which significantly increased the ratio of cycle 1 plants from 0.5% to 2.5%. After inbreeding (selfing) the parents, F_2 inbred lines failed to generate cycle 1 flowering inbreds and, instead, flowered later in cycles 2-3. However, inbreds originating from the recurrent selection progeny resulted in 1.47% of inbred cycle 1 plants. Due the precise selection for early seed germination and flowering, several genotypes show a pattern of reduced dormancy. These reduced dormant gladiolus corms were able to flower without a cold treatment, which contradicts the norm for commercial gladiolus production. This indicates that reduced dormancy is vernalization-independent and changes the Mediterranean type gladiolus into a subtropical type. In addition to reducing the juvenile period, cycle 1 gladioli have potential uses in potted plant production, as the plant height of cycle 1 plants is suitable for potted production. Future selection is still ongoing to increase the percentage of cycle 1 gladiolus in inbred and hybrid generations.

Specified Source(s) of Funding: Minnesota Agricultural Experiment Station

11:00 AM – 11:15 AM

Female Ploidy and Flower Size Influence Pollen Tube Growth and Seed Viability in Interploidy Crosses of *Hydrangea Macrophylla* l.

Lisa Alexander*, USDA-ARS

Polyploidy – also known as whole genome duplication – has long been associated with changes to ornamental traits in plants. Interploidy hybridization which results in fertile progenies may generate new, desirable traits in established hydrangea cultivars or allow for the transfer of traits between hydrangea species. The objective of this study was to compare pollen tube development, seed set, and seed viability among intra- and interploidy pollinations of *Hydrangea macrophylla*. Three triploid (3n) *Hydrangea macrophylla* cultivars (Blaumeise, Kardinal, and Taube) and two diploid (2n) cultivars (Oakhill and Decatur Blue) were used to make a series of reciprocal crosses. There were significant associations between cross type and percentage of flowers with pollen tubes reaching the ovaries at 24 h ($\chi^2 = 30.6$, $p < 0.001$) and 48 h ($\chi^2 = 26.5$, $p = 0.001$) post-pollination. After 24 h, pollen tubes had reached the ovaries of 48.7% of 2n and 8.7% of 3n flowers, respectively. There was no difference in percentage of pollen tubes reaching the ovaries in diploid and triploid flowers at 72 h after pollination ($\chi^2 = 7.5$, $p = 0.60$). Analysis of covariance showed that pollen tube length was significantly influenced by ploidy of the female parent and the flower length of the female parent. Crosses between two triploid parents produced an average of 24 seeds per fruit, while 2nx2n, 2nx3n, and 3nx2n crosses produced an average of 6.7, 5.2, and 6.7 seeds per fruit, respectively. Germination rate was highest in 2nx2n crosses (46%) followed by 3nx3n (6%), 3nx2n (1.7%), and 2nx3n (0%) crosses. All resultant progenies will be evaluated for genome size and ornamental characteristics. These variants produced via interploidy crossing will broaden the gene pool of cultivated *Hydrangea macrophylla*.

11:15 AM – 11:30 AM

Phenotypic Evolution of Floral Organs in *Malus* Using Frequency Distribution Functions

Ting Zhou*[1]; WangXiang Zhang[1]; Donglin Zhang[2]; Junjun Fan[1] and Fuliang Cao[1], (1)Nanjing Forestry University, (2) University of Georgia

Abstract: The phenotypic diversity of floral organs plays an important role in the study of plant taxonomy and genetic evolution. Previous studies had concentrated on the direction of evolution, but not the degree of evolution. Box plot and frequency distribution function method were applied and evolutionary rules of the phenotypic traits of floral organs in *Malus* species and cultivars were explored in three dimensions of numeric value, size, and morphology. With respect to the direction of evolution, the floral organs showed a consistent trend of quantitative petaloid conversion (pistils or stamens → petals), size miniaturization (large → small), and morphological narrowness (petal shape: circular → elliptic; sepal shape: triangular → lanceolate) by both methods. In term of the degree of evolution, frequency distribution function analysis revealed clearer evolutionary changes than the box plot method in *Malus* taxa, which were characterized by size traits > quantitative traits > morphological traits and by horizontal dimensions > radial dimensions. Our findings suggested that the frequency distribution function analysis should be sensitive to reveal both the direction and degree of evolutionary changes in phenotypic traits of floral organs. We can construct a putative flower types for *Malus* breeding and provide a quantitative method for future evaluation of evolutionary rules among different populations in the plant world.

key words: *Malus* spp.; floral traits; evolutionary degree; evolutionary direction; frequency distribution

Specified Source(s) of Funding: The Priority Academic Program Development of Jiangsu Higher Education Institution (PAPD) (164010018), the National Germplasm Center of Crabapple in China (164010065) and Jiangsu Provincial Science and Technology Department (BE2017375-2).

11:30 AM – 11:45 AM

Linkage Mapping in Segmental Allopolyploids: A Case Study in Rose

Jason Zurn[1]; David Zlesak[2]; Matthew Holen[3]; James M. Bradeen[3]; Stan C. Hokanson[3] and Nahla Bassil*[4], (1)USDA-ARS NCGR, (2)University of Wisconsin, River Falls, (3)University of Minnesota, (4)USDA-ARS Corvallis

Genetic mapping in polyploid organisms that undergo random pairing during meiosis can be a complex process. Early genetic maps were constructed using single dose allele markers that segregate 1:1. These markers are incapable of being used to identify homoeologous or ohnologous chromosomes. Recently, software capable of identifying allelic dosage for SNP markers and mapping software that allows for the use of higher-dose markers has become available. This has allowed for great advancements in the mapping of segmental allopolyploids, like hybrid roses. The black spot resistance gene *Rdr3* was previously identified in the tetraploid rose 'George Vancouver' but has not been mapped. As such, a mapping population was developed by crossing 'George Vancouver' with the susceptible tetraploid rose 'Morden Blush'. Phenotyping was conducted via a detached leaf assay with the *Diplocaron rosae* race 8 isolate ACT. The population was genotyped with the WagRhSNP 68K rose Axiom array and allelic dosages were called using the R package 'fitPoly'. Genetic mapping was conducted using the R package 'polymapR', that allows for the use of single and higher-dose markers for triploid, tetraploid, and hexaploid populations. *Rdr3* was mapped to a chromosome 6 homoeolog. To date, three additional black spot resistance genes have been mapped (*Rdr1, Rdr2,* and *Rdr4*). Both *Rdr1* and *Rdr2* map to a chromosome 1 homoeolog and *Rdr4* maps to a chromosome 5 homoeolog. Because *Rdr3* maps to a different region than any of the previously mapped genes, it is a unique gene and not an allele of the other genes. The mapping of *Rdr3* demonstrates how new analysis tools can be used to create maps with much greater marker density for polyploids and begin answering some of the complex genetic questions surrounding them.

Specified Source(s) of Funding: USDA-NIFA-SCRI Grant 2014-51181-22378, RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars

Tropical Horticultural Crops

Moderator: Alyssa Cho
University of Hawaii at Manoa, Hilo, HI, USA

10:30 AM – 10:45 AM

Five New Selections of Macadamia for Hawaii

Alyssa Cho*, University of Hawaii at Manoa

Macadamia nut (*Macadamia integrifolia*) is one of the most important agricultural commodities for the state of Hawaii with 18,000 acres in production and a farm value of $53.9 million. Although many of the commercial plantings in the state are made up of cultivars developed in Hawaii, no new cultivars have been released in Hawaii recently. High quality, good yield, and tree shape are characteristics of selections chosen for a multi-site trial of macadamia selections from the University of Hawaii at Manoa. Five new selections and two released selections ('344' and '800') were evaluated at two locations on Hawaii Island (Waiakea Research Station and Kainaliu Research Station). Fields were established in 2001 and yield and quality data collections began in fall of 2015. Three full years of data were collected. Location significantly affected yield and quality, with yields being higher at the Kainaliu Research Station than at the Waiakea Research Station. Several selections of macadamia ('879', '887' and '900') yielded higher than the released selections '344' and '800'. Quality of these selections was also high, with good kernel recovery and acceptable kernel weights.

Specified Source(s) of Funding: Hatch Funds (USDA-NIFA)

10:45 AM – 11:00 AM

Growth and Fruit Quality of Pineapple Varieties in Taiwan

Jou-Yi Lee*; Ching-Shan Kuan and Chia-Hui Tang, Department of Horticulture, Chiayi Agricultural Experiment Station

Pineapple (*Ananas comosus* (L.) Merr.) is an important fruit crop in Taiwan. The adoption of pineapple varieties and farm practices have changed and increased pineapple cultivation. Taiwan is located at the tropical and subtropical boundary, where pineapples can be grown and harvested year-round. It is known that quality of pineapple is highly affected with changes in climate during different seasons. Recent dietary changes, high labor costs and variability in climatic factors have been challenging pineapple production in Taiwan. In the past 50 years, the 'Smooth Cayenne' pineapple variety was mainly produced for canned fruits. In line with global trade trends, the Taiwanese canned pineapple industry has been replaced by the fresh fruit market. Nowadays, the Taiwanese varieties 'Tainung No.16', 'Tainung No.17', and 'Tainung No.20' are mainly grown in southern Taiwan. Data has revealed the superior growth and quality of 'Tainung No.17'. Special fragrant flavor and delicate texture make 'Tainung No.17' as the most popular and promising variety for consumers and farmers. Proper adoption of pineapple varieties is critical for maintaining fruit quality and food security under changing climatic conditions. More research is needed on pineapple varieties to allow Taiwan to continue adapting to the national consumption pattern.

Specified Source(s) of Funding: Taiwan Agricultural Research Institute

11:00 AM – 11:15 AM

Interaction of Propagation Material and Environmental Factors on Rhizome Production of Ginger (*Zingiber officinale)*, Galangal *(Alpinia galanga*), and Turmeric (*Curcuma spp.*)

Sofia J Flores*[1]; Rosanna Freyre[2] and Paul R. Fisher[1], (1) University of Florida, (2)Univ of Florida

The objective was to evaluate yield of ginger, galangal and turmeric propagules produced under two photoperiods in a greenhouse environment. Propagules included micropropagated plantlets ("tc") or rhizomes ["ownrhiz"; second generation tc harvested after ~1 year of growth, or commercial sources of Hawaiian-grown rhizome (“rhiz”)] of several ginger, galangal, blue, yellow and white turmeric genotypes. Plants were grown from April, 2018 in 2.78 L pots and then transplanted in June 27 into 14.5 L containers filled with a blend of pine bark, Canadian *Sphagnum* peat moss, perlite and vermiculite. Long day photoperiods were provided in one greenhouse from July 6 onwards with night interruption lighting from 10 pm to 2 am using incandescent lamps at 1.32 $\mu mol \cdot m^{-2} \cdot s^{-1}$, with 26.8 ± 3.9°C day and 21.4 ± 2.1°C night temperatures, and 8.4 ± 3.8 $moles.m^{-2}.d^{-1}$ daily light integral (DLI). In a separate natural day greenhouse, day and night temperature were 26.6 ± 3.1°C and 21.3 ± 2.6°C, respectively, with 9.1 ± 3.6 $moles.m^{-2}.d^{-1}$ DLI. Within each greenhouse, containers were arranged in a randomized complete block design with three blocks (benches) and six replicate pots per propagule type. Plants were harvested between Jan and Feb, 2019. Under both natural and long days yields (rhizome fresh mass) were similar (on average 0.89 and 0.95 kg per container, respectively). Under natural days, ginger “ownrhiz” and galangal “tc” had the highest yields (1.44 and 1.31 kg, respectively). Ginger Bubba baba and turmeric Black had significantly lower yields (0.46 and 0.47 kg, respectively). While “rhiz”-grown ginger had more yield (1.44 kg) than “tc” ginger (0.96 kg), there was no difference between turmeric Yellow “ownrhiz” (0.68 kg) and Yellow “tc” (0.62 kg). Under long days, there were no significant differences on yield for ginger type. Yields ranged from 1.1 kg in ginger “tc” to 1.5 kg in ginger “ownrhiz”. Ginger Bubba baba “rhiz” had higher yield (1.2 kg) than when grown under natural days (0.5 kg). However, yield was significantly different for turmeric types. White “tc” had the highest yield (1.1 kg), while yellow “ownrhiz” had the lowest yield (0.5 kg) which was not different from yellow “tc” (0.6 kg). An additional experiment is underway evaluating the same set of propagule types grown in the field under full-sun or shade. Overall, research showed differences in yield depend upon genotype, plant material, and environmental conditions, and an economic analysis is needed to identify the most efficient production conditions.

11:15 AM – 11:30 AM

Micro-Structure, Photosynthetic Profile and Oxidative Stress Response of *Amaranthus Cruentus* L. to Phased Salinity

Odunayo Clement Adebooye*, University of Manitoba

We hypothesized that phasing of timing of salinity stress imposition will result in improved oxidative stress defence in an African leaf vegetable, *Amaranthus cruentus* L. We imposed salinity on the plants at 2-leaf stage, 4-leaf stage and 5-leaf stages of growth while plants that received no salinity treatment served as control. The five levels of salinity were 0 (control), 60, 100, 140 and 180 mM NaCl in four replications, corresponding to 1.2, 8.4, 12.5, 16.6 and 22.4 dS/cm electrical conductivities, respectively. Scanning electron microscopy (SEM) showed a concentration of discernible segmented trichomes on the veins of adaxial leaf surface while the trichomes are evenly distributed on the abaxial leaf surface. Significantly higher amounts of carotenoids, flavonoids, chlorophyll ‘*a*’, ‘*b*’ and total chlorophyll were found in the control plants and 5-leaf stage plants compared to plants that started receiving salinity treatment at 2-leaf and 4-leaf stage. Chlorophylls ‘*a*’ and ‘*b*’ were maintained in approximately ratio 5:1 irrespective of the salinity rate. It is noteworthy that the higher the salinity level (within a range of 0-180 mM), the lower the leaf tissue content of elemental Ca and the higher the K. The antioxidative potential, falavoniods, carotenoids, relative photochemical efficiency (*Fv/Fm*), net photosynthesis (*A*), intercellular carbon dioxide concentration (C_i) and stomata conductance (g_i) decreased as salinity level increased. The older the plant before the imposition of salt stress, the better the ability of the plant to tolerate the stress. These results can assist in appropriate transplanting decision in saline locations for *A. cruentus* leaf and seed production.

Specified Source(s) of Funding: The research fellowship awarded to Prof Dr. O.C. Adebooye by the Alexander von Humboldt(AvH) Foundation, Germany provided the funds for this work, and it is gratefully acknowledged. We thank Mr Knut Wichterrich for the SEM analyses.

11:30 AM – 11:45 AM

Evaluation of New Taro Varieties Resistant to Taro Leaf Blight in Hawaii

Rosemary Gutierrez-Coarite*[1]; Robin Shimabuku[2]; Kylie L.T. Tavares[2]; Lynn Nakamura-Tengan[2]; James E. Keach[3] and Susan C. Miyasaka[2], (1)310 Kaahumanu Ave., Bldg. 214, (2)University of Hawaii at Manoa, (3)University of Hawai‘i at Mānoa

Taro leaf blight, caused by *Phytophthora colocasiae* Racib, is the most important and damaging diseases of taro worldwide. Taro leaf blight could reduce taro corm yield by 50% or more in highly susceptible taro cultivars. Leaf yield losses of up to 95% have occurred for susceptible cultivars in Hawai‘i. Epidemics could completely destroy susceptible cultivars in the field. Poi quality could be reduced, because reduced photosynthesis could result in decreased production of gums and starches. Resistant cultivars offer the best sustainable management strategy against taro leaf blight. However, desirable characteristics and qualities are often lost during breeding. Thus, breeding for taro leaf blight resistance should focus on maintaining or improving desirable qualities, such as larger corms, shorter time to plant maturity, and improved taste and texture. Taro Leaf Blight resistant cultivar trials are being conducted throughout the State on Hawaii. The cultivars with greater than 50 % higher yields compared to the control Hawaiian cultivar (Maui Lehua) were 1016-03, 1003-03, 1003-13, 1024-209, 1024-15 and 1005-84. The cultivars 1016-03 and 1003-3 were the most desirable with good flavor, sweetness, stickiness and overall eating quality. These new cultivars are potential alternatives for taro growers in Hawaii.

Specified Source(s) of Funding: This work is supported by the USDA National Institute of Food and Agriculture, Hatch project HAW08043-H, managed by the College of Tropical Agriculture and Human Resources.

Genetics & Germplasm 3

Moderator: James McCreight
USDA-ARS, Salinas, CA, USA

10:30 AM – 10:45 AM

Variation in Sugar Concentration in Edible Podded Beans (Phaseolus vulgaris) Sample from the USDA Core Collection

Wesley D Gartner[1]; Paul Bethke[2]; Theodore J. Kisha[2] and James Nienhuis[*3], (1)University of Wisconsin, (2)USDA-ARS, (3)University of Wisconsin-Madison

Glucose, fructose, and sucrose concentrations contribute greatly to the sweetness and flavors of the foods we eat, including snap beans (Phaseolus vulgaris). Little is known about the patterns of sugar development between the edible pod and seed tissues that make up a snap bean. This study analyzed concentrations of glucose, fructose, and sucrose in 87 accessions of Phaseolus vulgaris from the USDA Core collection using high-performance liquid chromatography. Significant differences in sugar accumulation patterns were observed among the accessions, and between pod and seed tissue types. Overall glucose and fructose concentrations are both highly negatively correlated with sucrose concentrations. The majority of glucose and fructose was concentrated in the pod tissues. Sucrose was generally (but not always) higher in pod tissue than seeds. Seed tissues are composed primarily of sucrose, and therefore overall sucrose levels had a high positive correlation with seed size (percent seed by weight). Overall, genotypes with smallest seeds had the highest total (glucose+ fructose+ sucrose) sugar content, whereas genotypes with the largest seeds had the lowest total sugar content. Although years were significantly different, genotype-by-year interactions were mildly significant only for sucrose content. However, a Spearman rank correlation (r=0.5379) suggests that the ranks were consistent over the years.

Specified Source(s) of Funding: USDA Hatch

10:45 AM – 11:00 AM

Variation for Heat and Salinity Stress Tolerance in Diverse Carrot Germplasm

Adam Bolton[1]; Aneela Nijabat[2]; Muhammad Mahmood-ur-Rehman[3]; A.T.M. Majharul Mannan[4]; Aamir Ali[2]; M.a. Rahim[4] and Philipp W Simon[*5], (1)University of Wisconsin, (2)University of Sargodha, (3)University of Agriculture, (4)Bangladesh Agricultural University, (5)USDA

Carrot production is constrained by heat and salt stress during seed germination and seedling growth in many global regions. Few studies have been published evaluating the effect of heat and salt stress on carrot seed germination and the effect of salt stress on seedling growth. The objectives of this study were to evaluate the response of diverse carrot germplasm to heat and salt stress, identify tolerant germplasm that may be used by plant breeders, and define the appropriate stress levels for assessing tolerance in germination carrot seed. This study coincides with evaluations of abiotic stress tolerance in field trials in Pakistan and Bangladesh at varying stages of growth. The data from these studies, combined with genomic and transcriptomic evaluations, has helped to elucidate the genetic control of abiotic stress tolerance in carrot.

Specified Source(s) of Funding: Global Crop Diversity Trust Project GS14014

11:00 AM – 11:15 AM

Preserving Apricot Genetic Resources

Maria Jenderek*, USDA ARS CARR; Justin Tanner, Colorado State University and John E Preece, National Clonal Germplasm Repository USDA-ARS

Preservation of apricot (*Prunus armeniaca* L.) is traditionally done in orchards requiring extensive land and labor and risk exposure to stressors. Alternatively, the species might be conserved by pollen or clonally by in vitro culture in slow growth conditions and cryopreservation of shoot tips. In vitro methods are effective; however, they are labor and cost intensive. Experimenting with four apricot cultivars (‘Moorpark’, ‘Patterson’, ‘Tracy’ and ‘Westley’), we were able to successfully modify a dormant bud (DB) technology developed originally for *Malus,* by using sucrose and antioxidant solutions. In winter harvested twigs were cut into 3.5 cm segments with at least one dormant bud and exposed to different combination of 0.3 and 0.75 M sucrose with vitamin C, L-proline, ABA, cysteine, or a combination of L-proline and ABA, for various times (3 to 16 h) prior to their desiccation (25-27% MC) in subzero (-5^{o}C) conditions. After desiccation the DBs were slow cooled (-5^{o}C to -30^{o}C) and immersed into liquid nitrogen vapor (LNV; -182 to -196^{o}C). The post LNV viability was tested in a greenhouse under high relative humidity of about 75%. Dormant buds that swell and showed any signs of growth were scored as ‘1’ (alive) versus ‘0’ (dead) with no signs of growth. Overall, the highest percent of post LNV DBs scored as ‘alive’ (60 %) was observed for 0.3 M sucrose (16 h) and 0.75 M (3 h); however, 95% of ‘Tracy’ DBs showed bud swelling when pretreated in this sucrose combination with 0.5 mM vitamin C.

Specified Source(s) of Funding: CRIS 3012-21000016-00-D

11:15 AM – 11:30 AM

An *in Vitro* Co-Culture System and Transcriptomic Approach to Test and Understand Genetic Resistance to Armillaria Root Rot in *Prunus*

An asterisk (*) in front of a name indicates the presenting author.

Sarah B. Miller*[1]; Christopher Saski[2]; Jeffrey Adelberg[2]; Gregory L. Reighard[2]; Guido Schnabel[2] and Ksenija Gasic[2], (1)Bioagricultural Sciences & Pest Management, Colorado State University, (2)Clemson University
Throughout the U.S., stone fruit and nut crops (peach in South Carolina, Georgia, and California; cherry in Michigan; almond in California) are under threat from Armillaria root rot (ARR), for which there are no long-term control or mitigation strategies. ARR is the main factor in mature orchard decline, and the causal fungi are comprised of multiple Armillaria species, which infect and reside in the root system and kill trees long before they reach their maximum productivity. There is one commercially available rootstock with resistance to ARR for peach (MP29), but it is not widely accepted by growers. Furthermore, ARR resistant rootstock development is hampered by the difficulties associated with inconsistent infection, time and other complexities in the greenhouse and field hotspots, respectively. To make advancements toward our understanding of resistance mechanisms expressed in the MP29 rootstock, we developed an even population of MP29 clonal propagates and a population of *Prunus persica* susceptible controls (GF305) and co-cultivated them with *Armillaria mellea* for a period of 12 weeks. We observed rapid canopy decline after 3 weeks in the inoculated GF305 genotype; while MP29 showed no signs of decline. Furthermore, the GF305 inoculated lines were completely dead at 8 weeks, while MP29 persisted well beyond 12 weeks, suggesting validation of resistance to heavy pathogen pressure in the *in vitro* system. To develop an understanding of the genetic mechanisms endowing resistance to ARR, we sequenced complete transcriptomes of both the GF305 and MP29 genotypes under inoculated and non-inoculated conditions. The *in vitro* co-culture system and gene expression analysis will be presented.

Specified Source(s) of Funding: USDA-AMS-SC-MP-2015-10.170

11:30 AM – 11:45 AM

Allelism of Resistance to *Cucurbit Yellow Stunting Disorder Virus*in Melon Accessions PI 313970 and TGR 1551

James D. McCreight*[1]; Eric T. Natwick[2]; William M. Wintermantel[1]; Ana I. Lopez-Sese[3] and María L. Gomez-Guillamon[3], (1)USDA-ARS, (2)University of California ANR, Cooperative Extension Imperial County, (3)IHSM-La Mayora, UMA-CSIC
Cucurbit yellow stunting disorder virus(CYSDV) is a whitefly-transmitted closterovirus that reduces melon (*Cucumis melo*) fruit yield and quality in greenhouse and open-field production systems in the Middle East, the Mediterranean Basin, the Americas, and Asia. Resistance to CYSDV was first reported in melon accession TGR 1551 (PI 482420) and then in PI 313970, both members of the *C. melo*Acidulus Group from Zimbabwe and India, respectively. Neither accession is immune to CYSDV infection. Resistance in TGR 1551 was initially reported to be dominant to susceptibility in controlled-inoculation greenhouse tests in Spain. Recessive resistance was observed in PI 313970 in naturally-infected field tests in Imperial Valley, California. This presented an opportunity for combining two potentially different genes to achieve a higher level of resistance than exhibited by either source alone. We thus crossed the two accessions with the goal of combining their resistances to CYSDV and initiated a selection program for CYSDV resistance and crossed their offspring with western U.S. shipper type muskmelon and honeydew, but higher levels of resistance were not observed in field selections. Resistance in TGR 1551 was subsequently found to be recessive. Analysis of disease reaction data from the two resistance sources, their two F_1, F_2, and testcross progenies in two naturally-infected field tests in Imperial Valley and a controlled greenhouse test in Málaga suggest resistance to CYSDV exhibited by these two lines may be allelic. PI 313970 and TGR 1551 exhibited high-level resistance in one test, where both accessions showed some variation in symptom expression, but their $F_1$was very uniform. In the second test, PI 313970 and the F_1 PI 313970 x TGR 1551 exhibited greater variation in symptom expression than TGR 1551. A significant difference between the parents in the second test indicates an effect on their different genetic background or quantitative trait loci (QTL) on expression resistance to CYSDV in the two lines. Research is underway to map their respective QTL for resistance to CYSDV in order to increase resistance to this virus.

11:45 AM – 12:00 PM

Evaluating a Hand-Held Visible and Near-Infrared Reflectance Technology as a High-Throughput Phenotyping Tool for Tomato and Pepper Fruit Quality Breeding

Amanjot Kaur*; Dina A. St. Clair and Irwin R. Donis-Gonzalez, University of California, Davis
Plant breeders must rapidly and accurately phenotype extensive numbers of field-grown plants across environments to identify superior plants or populations and make selections. Trait phenotyping and associated labor, time and resources serve as the bottleneck of the breeding pipeline and one of the primary constraints in plant breeding. This bottleneck further intensifies for data collection of physiochemical and fruit quality traits, which typically involve laborious postharvest processing and laboratory assays. Relatively little research has been done on fruit phenotyping with portable hand-held instruments that are easy to use, are non-destructive and robust to withstand real-time field conditions. The objective of our multidisciplinary study was to evaluate the potential of a recently industrialized postharvest quality spectrophotometer, Felix, to be implemented as an in-field high-throughput phenotyping tool for fruit quality and physiochemical traits integral in tomato and pepper breeding. In

replicated field experiments during summers of 2017 and 2018 in Davis, CA, we studied traits of pH, soluble solids and carotenoids in tomato and shrink, pericarp thickness, and carotenoids in pepper. Genetic material for tomato was comprised of inbred cultivars and introgression lines containing chromosomal introgressions from water-stress tolerant wild tomato *Solanum habrochaites* accession LA1777 in a *S. lycopersicum* inbred processing tomato cultivar E6203 background. Genetic material for pepper was comprised of diverse hybrid and open-pollinated cultivars of New Mexican chile, yellow wax and sweet bell peppers. Primary approach of our study involved partial least squares regression (PLSR) as a chemometric (computational chemistry) tool to build trait-based regression models using visible and near-infrared spectroscopy data from Felix. Secondary approach assessed patterns in the spectroscopy data based on variables of in-field irrigation treatments and fruit color. Tertiary approach evaluated associations between wavelength-specific spectroscopy data and plant variables such as genotypes, water treatment, and genotype x water treatment interaction. Results of our study revealed 1) the scope of Felix's usage in tomato and pepper fruit quality breeding, and 2) insights into the complex relationship of vis-NIR spectroscopy with fruit biology, in-field environmental conditions, and genetic diversity.

Viticulture and Small Fruits 3

Moderator: Mehdi Sharifi
Agriculture and Agri-Food Canada, Summerland, BC, Canada

10:30 AM – 10:45 AM

Exploring the Potential of Postharvest Nitrogen Applications in Northern Highbush Blueberry

Amit Bhasin*, Washington State University Irrigated Agriculture Research and Extension Center; Joan R. Davenport, WSU Prosser; Gwen Hoheisel, WSU Regional Extension Specialist, Benton County Director and Lisa Wasko DeVetter, Washington State University Northwestern Washington Research and Extension Center

In northern highbush blueberry (*Vaccinium corymbosum*), bloom to fruit maturity is a period of rapid growth and nitrogen (N) uptake. Growers are advised to ensure that sufficient N is available to plants during this period of growth and often accomplish this through fertilizer applications from bloom through fruit development. In northern climates like Washington State, postharvest applications of N fertilizer is not recommended in highbush blueberries because it may stimulate excessive vegetative growth, reduce floral bud set, and increase the risk of winter injury through delayed acclimation. However, postharvest N applications in perennial crops like blueberry may positively contribute to the N storage pool, which could be used later and re-allocated according to plant demand in subsequent years. Early-fruiting cultivars with the potential for an extended growing season after harvest may particularly benefit from postharvest N applications, as the additional N may promote shoot and root growth that could support fruit production in future years while still allowing plants to form floral buds and acclimate to winter temperatures. The objective of this study is to assess the impact of postharvest N applications in early-fruiting 'Duke' blueberry on plant vegetative growth, nutrient status, yield, fruit quality, floral bud set, and cold hardiness. Four treatments varying in timing of N application were evaluated using a single fertilizer rate of 129 $kg \cdot ha^{-1}$ N in 2018. Treatments were arranged in a randomized complete block design with four replications and included: 1) Control (100% of N applied pre-harvest); 2) 80/20 (80% pre-harvest, 20% post-harvest); 3) 70/30 (70% pre-harvest, post-harvest); and 4) 60/40 (60% pre-harvest and 40% post-harvest). Overall, no significant differences were observed in any of our measured variables. Leaf tissue N concentrations were at 1.40-1.69%, which is below the recommended range of 1.76-2.0%. However, no indications of N deficiency were observed in the plants and this range is common in the region where the study was conducted. Plants receiving the control treatment tended to acclimate sooner, but no differences in winter injury was observed in the field. The overall lack of statistical differences was expected as woody perennials with stored nutrient pools take time to respond to fertilizer treatments and this was the first year of the study. While this study is in progress and will be repeated in 2019, the results will optimize nutrient management practices and guide growers on optimal timing of N applications for early-fruiting blueberry cultivars.

Specified Source(s) of Funding: Washington Blueberry Commission

10:45 AM – 11:00 AM

Living Mulches and Micro-Irrigation for Reducing Runoff and Erosion during Bare-Root Strawberry Transplant Establishment

Lillian R Pride*; Carlene A. Chase; Kati Migliaccio and Zach Brym, University of Florida

High volumes of sprinkler irrigation are used in Florida for bare-root strawberry transplant establishment. Microsprinklers and living mulches in the row middles were proposed to conserve water and to limit runoff and erosion. The effects of conventional impact sprinklers and microsprinklers in the main plots of a split-plot experiment and of living mulch treatments in the subplots were compared on runoff, erosion, and soil pore water as well as on strawberry (Sweet Sensation® 'Florida 127') yield. Hairy indigo (Indigofera hirsuta L.; 20 lb/acre in 2017 and 30 lb/acre in 2018), sunn hemp (Crotalaria juncea L. cv AU Golden; 40 lb/acre in 2017 and 60 lb/acre in 2018), and slenderleaf rattlebox (Crotalaria ochroleuca G. Don; 40 lb/acre both years) were planted on Sep. 28, 2017 and Aug. 29, 2018 and compared to a weedy control. Runoff and erosion were assessed using runoff/erosion capturing devices at the end of one row middle per subplot. Soil pore water was measured in the same row middle using a suction lysimeter. Microsprinklers resulted in 33% (2017) and 28% (2018) the water use of impact sprinklers. Compared to impact sprinklers (1828 L/ha runoff in 2017, and 122 and 27 kg/ha erosion in 2017 and 2018, respectively), microsprinklers had a 77% decrease in runoff in 2017 with no significant difference in 2018, and 79% and 49% reductions in erosion in 2017 and 2018, respectively. Hairy indigo, sunn hemp, and slenderleaf rattlebox resulted in 22.1, 13.9, and 28.0 mL soil pore water, respectively, compared to 57.2 mL in the weedy control. However, living mulches had no significant effect on runoff and erosion. Neither early nor total strawberry yield were significantly affected by either irrigation or living mulch treatments. For strawberry growth parameters, microsprinklers (34 cm) had 4% greater shoot diameter than impact sprinklers (33 cm/plant), and control plots had 10% and 19% greater leaf number (22 leaves/plant) and crown diameter (47 mm/plant) than hairy indigo plots (20 leaves/plant and 39 mm/plant), respectively. Only hairy indigo and slenderleaf rattlebox significantly reduced weed biomass, to 3 and 8 g/m^2, respectively, compared to 17 g/m^2 with the weedy control. Results indicated that using microsprinklers during bare-root strawberry transplant establishment instead of impact sprinklers can maintain strawberry plant growth and yield while decreasing water use, runoff, and erosion. While the living mulches had no impact on runoff and erosion, hairy indigo and slenderleaf rattlebox suppressed weed biomass in row middles.

Specified Source(s) of Funding: Florida Department of Agriculture and Consumer Services

11:00 AM – 11:15 AM

Reflective-Striped Plastic Mulch: New Technology for Winter Strawberry Production to Improve Early Yields By Modifying Soil and Canopy Microenvironments

Shinsuke Agehara*; Stephen S Deschamps and Vance M Whitaker, University of Florida

Winter strawberry (*Fragaria ×ananassa* Duch.) production in Florida is subjected to excessively high temperatures during establishment and cool temperatures in the peak season. To mitigate the negative impact of such seasonal temperature extremes, we developed a new plastic mulch film that has a 51-cm wide, reflective center stripe with black shoulders. The reflective center stripe is a 25-nm-thick layer of aluminum. The effects of this plastic mulch on microenvironments and fruit yields were examined in field experiments over three seasons. Compared to black plastic mulch, the metalized-striped mulch reduced root-zone, canopy, and crown tissue temperatures during establishment, while maintaining the equivalent soil warming during winter months. In addition, spectroradiometer measurements determined that more than 95% of sunlight was reflected by the metalized-striped mulch. Furthermore, the reflected light had a lowered red/far-red ratio, which is the beneficial light quality to stimulate floral initiation in strawberry. The striped mulch increased early-season and total yields consistently by up to 34% and 26%, respectively. Our results demonstrate that the striped mulch can serve as a new technology to improve yields and earliness for winter strawberry producers.

Specified Source(s) of Funding: Florida Strawberry Research and Education Foundation; IMAFLEX, Inc.

11:15 AM – 11:30 AM

The Effects of Four Different Cover Crops on Malbec Vines in a Semi-Arid Southwestern Vineyard

Jacqueline Cormier*[1]; William Giese[1] and Ciro Velasco-Cruz[2], (1)New Mexico State University, (2)New Mexico State Univ

Wine grapes, *Vitis vinifera*, have been grown in New Mexico since the 1600's and the 2012 Census of Agriculture estimates that 516 farms in New Mexico are currently growing grapes. Despite this, very little research is currently being done to help tailor cultural practices specifically for the semi-arid southwestern environment. In Las Cruces, NM, a study was designed to compare the effects of four different inter row cover crops of Malbec grape vines. The long-term goal of this study is to quantify the effects of the four cover crops on the vineyard ecosystem to assess the cover crops for fitness as an alternative ground cover. The current industry standard in vineyard row spaces is to maintain bare soil through the regular use of herbicides, cultivation and hand removal of weeds. This practice is costly and labor intensive for local growers. In addition, the windy, dry New Mexico growing conditions may exasperate challenges like the management of top soil loss over time when left bare. For this study, ten rows of Malbec vines were planted in a vineyard and were seeded with one of four cover crops, a native grass mix, 'Balanza' clover, a native flowering mix, and triticale. These ground covers were chosen for their suitability to the local climate and their benefits to different aspects of the vineyard ecosystem. The cover crops were assessed for fitness by measuring their effects on soil moisture content, vine and leaf moisture as well as their effect on the weed and insect populations once established.

11:30 AM – 11:45 AM

The Interactive Effect of Intra-Row Cover Cropping and Charged Biochar on Wine Grape (*Vitis vinifera* L.) Yield and Cover Crop Biomass in an Irrigated Vineyard

Mehdi Sharifi*[1]; Denise Neilsen[1]; Gerry H Neilsen[1]; Tom Forge[1] and Kirsten Hannam[2], (1)Agriculture and Agri-Food Canada, (2)Summerland Research and Development Centre

Ground cover in vineyards suppresses weeds and contributes to several essential ecosystem services, such as, water infiltration, carbon sequestration, nutrient retention, soil erosion control, and provision of habitat and biodiversity.

Despite increasing interest in the adoption of cover crops in vineyard systems, there remains concern over the implications of competition between grapevines and cover crops for water and nutrient availability. The positive role of biochar on regulating water availability in vineyards with cover crops has been reported in Mediterranean climates, but the implications for fruit quality and yield are poorly understood. Charging biochar with compost can reduce subsequent nitrogen and carbon losses, enhance carbon sequestration, and increase mineral N through accelerated mineralization. The interactive effects on yield and yield quality of cover crops and charged biochar applications in the alleyways between vines were examined of a Merlot (*Vitis vinifera* L.) vineyard in the semi-arid Okanagan Valley, British Columbia, Canada. Cover crop and charged biochar treatments were applied to the alleyways between vine rows in a factorial design. Charged biochar was produced by mixing biochar and compost at 1:1 ratio three weeks before spring application. Charged biochar was applied at a rate of 22 Mg ha^{-1} (dry weight basis). The cover crop treatment was a mixture of southern interior dryland forage species + birds foot trefoil *(Lotus corniculatus* L.), sown at a rate of 22.4 kg ha^{-1} and 6.7 kg ha^{-1}, respectively. Both alleyway cover crops and amendment with charged biochar increased fruit yield by ~ 42%; however, combination of the two treatments did not change the yield compared with vegetation-free, unamended control treatments. The effects of treatment applications on grape yield quality and cover crop biomass will also be discussed.

Specified Source(s) of Funding: British Columbia Wine Grape Cuncil and Agriculture and Agri-Food Canada

11:45 AM – 12:00 PM

Effects of Light Emitting Diode Irradiation at Night on Abscisic Acid Metabolism, Anthocyanin and Sugar Syntheses in Grapes in Different Growing Seasons

Satoru Kondo*, Chiba University

The effects of red- and blue-light irradiation at night on abscisic acid (ABA) synthesis and anthocyanin and sugar concentrations were examined in grape vines, which were grown in two different seasons. In grapes cultivated with early heating, the ABA concentrations were highest in blue-light-emitting diode (LED)-treated skin; however, those in grapes cultivated in the ordinary growing season were highest in red-LED-treated skin. The expressions of 9-*cis*-epoxycarotenoid dioxygenase (*VvNCED1*) and ABA 8’-hydroxylase (*VvCYP707A1*) were high in each treatment at veraison regardless of the growing season. In both seasons, anthocyanin concentrations were highest under the blue-LED treatment, followed by the red-LED treatment. The expressions of *VlMYBA1-2*, *VlMYBA2*, and *VvUFGT* coincided with anthocyanin concentrations. Sugar concentrations were increased by the blue- or red-LED treatment dependent on the growing season. The results suggest that blue- or red-LED irradiation at night may influence the ABA and anthocyanin metabolism including *VvNCED1, VlMYBA1-2*, and *VlMYBA2* and sugar synthesis in grape berries, although the degree of the effects differs with the growing season.

Produce Quality, Safety, and Health Properties

Moderator: Kelly M. Gude
Kansas State University, Olathe, KS, USA

10:30 AM – 10:45 AM

Variation of Minerals Concentration in a Selection of Seventeen Microgreens Species

Francesco Di Gioia*[1]; Cristina Pisani[2]; Jason C. Hong[2] and Erin N. Rosskopf[2], (1)The Pennsylvania State University, (2)USDA-ARS

Popular among chefs as garnish greens, microgreens are also considered a valuable source of antioxidant compounds and nutrients, including minerals. Seventeen species of microgreens belonging to seven different botanical families and commonly grown for their interesting color, shape, texture, and/or flavor were selected to investigate the variation of macro- and micronutrients in the edible portion. Microgreens were grown in a greenhouse using a soilless system and a natural-fiber felt as a growing medium. A modified half-strength Hoagland solution with no microelements was prepared using deionized water and applied from seed germination until harvest. Treatments were arranged in a randomized complete block design with three replications. At harvest, conducted from 10 to 19 days after sowing depending on the species, fresh yield and shoot mean fresh weight and dry matter content were measured. Dry tissue samples were analyzed for the concentration of total nitrogen (N), NO_3-N, P, K, Ca, Mg, S, Na, Fe, Zn, Mn, Cu, and B. Significant genotypic variations were observed for all minerals measured. Total-N ranged between 212.3 and 421.3 mg 100 g^{-1} fresh weight (FW) and was not correlated to NO_3-N concentration. Excluding sunflower, all other genotypes had high (1,000-2,500 mg kg^{-1} FW) or very high (>2,500 mg kg^{-1} FW) NO_3^- concentrations. Phosphorous concentration ranged between 28.35 and 66.05 mg 100 g^{-1} FW and none of the genotypes may be considered as a good source of P. Lemon balm, beet, and amaranth had the highest concentrations of K, while sunflower, radish and kale had about one fifth of the K concentration. Amaranth was also a good source of Ca and Mg. Besides amaranth, scallion, red cabbage, and Genovese basil were good sources of Ca proving over 15% of the daily Ca requirement. The concentration of S was significantly higher in all *Brassicaceae* and in scallion compared to the other species. All the microgreens tested had very low Na concentration (<15 mg 100 g^{-1} FW). Sunflower, scallion, and shiso had the highest concentrations of Cu and could be considered a good source of Cu. The same species and amaranth had high concentrations of Fe, while sunflower had the highest concentration of Zn; however, considering the daily recommended dietary allowance for adults, none of the species could be considered adequate dietary sources of Fe or Zn, suggesting that there is potential to fortify microgreen concentrations of essential micronutrients.

10:45 AM – 11:00 AM

Buyer-Rated Red Lettuce Sensory Appeal As a Function of High Tunnel-Based Crop Growing Environment

Dana Hilfinger[1]; Joseph C. Scheerens[2]; Chieri Kubota[1] and Matthew D. Kleinhenz[*2], (1)The Ohio State University, (2) The Ohio State University-OARDC

Aerial coverings within high tunnels (HTs) modify crop microenvironments, which is especially important fall-to-spring in mid and upper latitudes. These microenvironments often increase yield but their influence on pigmentation and other variables shaping consumer sensory appeal are unclear. We are investigating sensory responses using panel evaluations of 'Outredgeous' red lettuce (*Lactuca sativa*) exposed to four aerial covering schemes for seven weeks then harvested at baby stage. Twenty 4.5-m^2 beds in a 9.1 m x 24.4 m HT in Wooster, Ohio were seeded in Fall 2017, Spring 2018, Fall 2018, and Spring 2019. All treatments began at approx. 80% plant emergence and involved the use of 0.03-mm thick vented polyethylene film and/or heavyweight row cover (50-AG Agribon): (1) covered with film always and row cover at night ("F-RC"); (2) covered with film always ("F"); (3) covered with row cover at night ("RC"), and; (4) uncovered ("C"). Row cover was in place daily beginning 15:00 to 18:00 and removed between 8:00 and 10:00. All vegetative tissue 1 cm above the soil line was sampled from 0.3-m^2 quadrats at weeks four and seven for measurements of fresh and dry weight, leaf area, total soluble solids (˚Brix), and total anthocyanin concentration. Environmental data were recorded seeding to harvest. Nightly row cover (F-RC and RC) treatments increased fresh weight and leaf area compared to beds without (F and C) in Fall runs. Sensory panels in Fall-2018 used material collected at week 7. First, in discrimination-based triangle tests, panelists were asked to differentiate treatment samples based on color. Second, panelists were asked to rank samples according to leaf color intensity and color distribution. Third, panelists were asked to indicate their preference for treatment samples included in a mesclun mix using a hedonic scale. In triangle tests, panelists responded correctly in all but two treatment comparisons (F vs C and F vs F-RC); samples in all other comparisons could be differentiated visually. C and RC treatments were ranked as more intensely red than F and F-RC treatments. Leaf red coloration was comparatively less evenly distributed in the F-RC treatment. Panelists indicated a similar liking for all samples when included in a mesclun mix. Preliminary lessons from this work include: (a) aerial covering programs can influence yield and (b) although leaves were identified as different when directly compared, differences did not affect preference for any treatment when incorporated into a mix, as baby red lettuce is commonly marketed.

Specified Source(s) of Funding: The Ohio State University

11:00 AM – 11:15 AM

Steaming Eliminates the Bitter Taste of Methyl Jasmonate Treated Broccoli

Yu-Chun Chiu[*1]; Kristen Matak[1] and Kang-Mo Ku[2], (1)West Virginia University, (2)Chonnam National University

Application of methyl jasmonate enhances the potential health-promoting compound, glucosinolates (GS), especially inducible indole GS-neoglucobrassicin in broccoli by mimicking insect attack. This application also increases the concentration of neoglucobrassicin-derived hydrolysis products, which were shown to be anti-carcinogenic. However, neoglucobrassicin were also associated with the perception of bitter flavor, and the sensorial quality of neoglucobrassicin-derived hydrolysis products are not clear. Because GS and the hydrolysis products may change the sensorial perception of the broccoli, the consumer acceptance of both raw and cooked MeJA-treated broccoli was investigated. The aim of this study was to determine if an untrained consumer panel can detect differences between control and 250 µM MeJA treated broccoli (raw or steamed 4 min) by sensory evaluation (triangle test, attribute test, and preference test) and to determine the key compounds responsible for the potential different overall preference of MeJA-treated and untreated broccoli.

Results of the triangle test showed that panelists were able to correctly identify the odd raw broccoli samples ($p<0.05$) but not the odd steamed broccoli samples ($p>0.05$), which is consistent with preference test results. Panelists only showed significant preference ($p<0.05$) of raw control broccoli, while no preference was found between steamed MeJA-treated and steamed control broccoli. MeJA treatment significantly increased neoglubrassicin by 7.6-fold in raw broccoli. *N*-methoxyindole-3-carbinol, *N*-methoxyindole-3-acetonitrile, and N-methoxyindolyl-3-carboxaldehyde (neoglubrassicin-derived hydrolysis products) were significantly increased ($p<0.05$) in raw MeJA-treated broccoli compared to raw control broccoli. After 4 min steaming, MeJA-treated broccoli still contained 7.8-fold more neoglucobrassicin and 50% more total GS than untreated broccoli. Four-minute steaming process may deactivate endogenous myrosinase and lead to the decrease in hydrolysis products; however, intact GS can be hydrolyzed by human gut microbes. Therefore, the higher concentration of GS in steamed broccoli still contributed higher nutritional quality. We included nine GS, 16 GS hydrolysis products, eight volatile compounds, and 14 primary metabolites for partial least square regression model. The model showed that *N*-methoxyindole-3-carbinol, *N*-methoxyindolyl-3-carboxaldehyde, and *N*-methoxyindole-3-acetonitrile were the most important metabolites in determining the overall liking of broccoli samples. The results suggest that the concentration of neoglucobrassicin-derived hydrolysis products in MeJA-treated broccoli have potential for use as an ingredient to boost the nutrition quality and/or as a value-added ingredient in precooked meals.

Specified Source(s) of Funding: National Institute of Food and Agriculture, U.S. Department of Agriculture, Hatch project number #WVA 00722 and 112506

11:15 AM – 11:30 AM

Optimization of Factors Influencing Quantitation of Carotenoids of Melon

Bhimanagouda S. Patil*; G.K. Jayaprakasha and Jashbir Singh, Texas A&M University

Carotenoids are C_{40} tetraterpenoid natural pigments present in fruits and vegetables. Extraction and precise quantitation of carotenoids is challenging due to their thermolabile and light sensitive nature. Extraction of carotenoids is influenced by different extraction methods, solvent polarity, and the plant matrix. Therefore, it is important to develop an efficient, effective, rapid qualitative and quantitative method for the analysis of carotenoids. In order to determine the optimal extraction conditions for cantaloupe, different blending times (1, 3, and 5 min) and various solvent combinations of chloroform, acetone, methanol and tetrahydrofuran were used. The results demonstrated that chloroform and acetone (1:3) is the optimal solvent for the extraction and chromatographic resolution of carotenoids. The optimized extraction involves fewer operations such as concentration of the extract to avoid the degradation of carotenoids before HPLC. The robustness of the optimized solvent and analytical method were validated using different cantaloupe varieties, tomato, watermelon, oranges, and grapefruit. Carotenoids such as lutein, cryptoxanthin, ζ-carotene, β-carotene, trans-lycopene, and their cis-lycopene isomers such as 5-cis, 7-cis, 9-cis, 11-cis, 13-cis, and 15-cis were successfully separated by HPLC with a triacontyl (C_{30}) stationary phase. This study provides a method for efficient extraction and rapid sample preparation for accurate analysis of carotenoids from different fruits and vegetables. This project based upon the work supported by NIFA-SCRI-2017-51181-26834 through National Center of Excellence for Melon at the Vegetable and Fruit Improvement Center of Texas A&M University.

Specified Source(s) of Funding: USDA-SCRI2017-51181-26834 through National Center of Excellence for Melon at the Vegetable and Fruit Improvement Center of Texas A&M University

11:30 AM – 11:45 AM

Effect of Grafting on Fruit Quality Traits of Tomato Grown Under High Tunnel and Open-Field Conditions

Madhumita Joshi*[1]; Daniel I Leskovar[2]; Desire Djidonou[3]; John Jifon[4]; Carlos A. Avila[1]; Joseph G. Masabni[5] and Kevin Crosby[6], (1)Texas A&M AgriLife Research, (2)Texas A&M AgriLife Research & Extension Center, Texas A&M University, (3)Texas A&M AgriLife Reserach, Texas A&M University, (4)Texas A&M AgriLife Research Center, (5) Texas A&M AgriLife Research & Extension Center, (6) Texas A&M University

Grafting in tomato using vigorous rootstock is mostly carried out to increase tolerance to biotic and abiotic stresses and improve crop productivity. However, limited information is available about the impact of somatogenetic interactions between rootstock and scion in tomatoes especially in defining the qualities of fruits. In this 2-year study, the effect of grafting on metabolic traits contributing to the quality of tomato fruits was evaluated in high tunnel (HT) and open field (OF) production systems across different growing environments (Overton, Uvalde, and Weslaco) in Texas. Six grafted treatments of two root-stocks ('Estamino' and 'Multifort') and two scions ('TAM Hot Ty' and 'Tycoon') in 2017; ('TAM Hot Ty' and 'HM1823') in 2018 were considered in each of the two growing seasons. Greater differences in fruit quality traits were due to the production system than grafting treatments. Except for a 10 to 18% significant decrease in ascorbic acid (Vit C) of grafted fruits, other metabolic traits including sucrose, glucose, fructose, °Brix, titratable acidity, polyphenol, and carotenoids (lycopene, β-carotene, lutein) were not significantly different between grafted and non-grafted fruits. In contrast, the production system (HT vs. OF) had a significant influence on the fruit quality. Specifically, significant increases in lycopene (36%), β-carotene (27%), fructose (16.7%), glucose (14.3%) and Brix/acid ratio (22%) were detected in tomatoes grown under the high-tunnel structure in 2017, but not in 2018. Tomato fruit quality was also impacted by the location in both the seasons. A significant seasonal variation explicitly for sugars (sucrose, glucose, and fructose) and anti-oxidants (lycopene, β-carotene, and lutein) was confirmed among the growing environments. Taken together, grafting along with the production system and growing environment greatly influenced quality traits in tomato fruits.

Specified Source(s) of Funding: Texas Vegetable Seed Grant

11:45 AM – 12:00 PM

Fate of *Listeria* on Granny Smith Apples Treated with Continuous Ozone during Cold Storage

Lina Sheng[1]; Manoella Mendoza*[2]; Xiaoye Shen[1]; Meijun Zhu[1] and Ines Hanrahan[2], (1)Washington State University, (2)WA Tree Fruit Research Comm

The objectives of this study are to assess the fate of generic *Listeria* on apple surfaces stored under regular atmosphere (RA, 33°F) and controlled atmosphere (CA, 33°F 1% CO_2, 2% O_2) with and without continuous low doses (~90 ppb) of ozone (O_3); examine survival of natural microorganisms on apple surfaces under above mentioned storage conditions and evaluate impacts of ozone on final fruit quality after storage. A 3-strain *L. innocua* cocktail prepared via mixing equal numbers of each respective strain suspension was used to inoculate unwaxed and unbruised Granny Smith apples at commercial maturity in 2017. Granny Smith apples were established to 6.09 ± 0.07 Log_{10} CFU/apple and held at room temperature for 24 hours, before being subjected to cold storage in a typical commercial apple facility. Inoculated Granny Smith apples were randomly separated into three groups and subjected to three different storage conditions: RA, CA and CA with a low dose ozone for up to 30 weeks. Apples under different storage conditions were sampled at 0, 1, 3, 6, 12, 18, 24 and 30 weeks of storage to analyze the survival of *L. innocua* on apple surfaces. Fruit maturity and quality measurements such as firmness, total soluble solids and titratable acidity were performed at harvest and after 30 weeks in storage. The 30 weeks quality evaluation was conducted after a week at room temperature. External disorders were evaluated after 1 day and 1 week at room temperature. During the first 3 weeks of cold storage, *L. innocua* was reduced by 1.0-1.4 Log_{10} CFU/apple. A single log reduction is equal to 10-fold or 90% reduction in *Listeria* population on apple surface. Die-off rate significantly decreased during the subsequent storage period. After 30 weeks of cold storage in a commercial RA or CA storage environment *L. innocua* on Granny Smith apple surface was reduced by 2.9, 2.2 and 4.6 Log_{10} CFU/apple in RA, CA, and CA + O_3, respectively. Surprisingly, apples subjected to RA had significantly less *L. innocua* compared to those stored under CA conditions. The natural bacteria level remained stable during 12-week storage. It slightly increased in both RA/CA during subsequent storage, while remaining similar or slightly decreased in apples under CA with continuous low dose ozone. Overall, ozone treatment did not affect fruit quality.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

12:00 PM – 12:15 PM

The Impact of Light on Yield and Nutritional Quality of Lettuce Grown in High Tunnels

Kelly M. Gude*; Cary L. Rivard; C.B. Rajashekar and Eleni D. Pliakoni, Kansas State University

UV-stabilized polyethylene commonly used for high tunnels reduces spectral quality by blocking UV-B and reducing light intensity by 15-20%. Both light intensity and spectral quality are known to impact the accumulation of several plant nutrients. The objective of this study was to evaluate the effect of 6 different high tunnel coverings (standard polyethylene (standard poly), luminance poly (diffuse), clear poly (clear), UVA+UVB blocking (-UVA/UVB), 55% shade cloth (shade), as well as a simulated movable tunnel (poly removal 2 weeks prior to initial harvest)) on photosynthesis, air and soil temperature, crop yield, storage life, and nutrient content of lettuce (*Lactuca sativa* L., red-leaf variety 'New Red Fire', and green-leaf variety 'Two Star'). Consecutive fall leaf lettuce trials were conducted at Kansas State University's Olathe Horticulture Research and Extension Center (OHREC) from October to December, 2017 and 2018. The trials were arranged in a RCBD and four individual high tunnels served as replications. Four-week old seedlings of 'New Red Fire' and 'Two Star' varieties were transplanted in staggered double rows. Soil/canopy temperatures were measured in 30 min increments. PAR and net photosynthetic rates were measured prior to harvest. For yield, total and marketable head weight (g/head), core length (cm), and leaf area (cm2) was measured. For phytochemical quality, phenolic acid and flavonoid contents (coumarin, chicoric acid, chlorogenic acid, caffeic acid, ferulic acid, rutin, kaempferol, naringenin, quercetin-3-o-glucoside and quercetin) were measured at-harvest and on day 5 after optimum postharvest storage. Storage quality was assessed by water loss (%) and color development throughout storage. Soil temperatures were 2 to 3 °F warmer for the diffuse and clear treatments in comparison to standard, poly removal, and shade treatments ($P < .0001$). The standard, poly removal, and diffuse treatments of the red and green leaf lettuce had approximately 30% greater fresh weight than the shade treatment ($P < 0.05$). The poly removal and clear treatments produced darker red pigmentation ($P < 0.01$) in red leaf lettuce in comparison to the other treatments. High tunnels offer a unique opportunity to manipulate light with various poly films and shade cloths which is not typically applicable for the open-field production. The present study is aimed to identify an optimal balance between production and nutrient content in lettuce, which is critically important for most food crops grown in high tunnels.

Specified Source(s) of Funding: USDA-NIFA

Vegetable Crops Management 5

Moderator: Tiare Silvasy
University of Florida, GAINESVILLE, FL, USA

10:30 AM – 10:45 AM

Stability of Yield and Yield Components of Grafted Tomato in Multiple Environments in Texas

Desire Djidonou*[1]; Daniel I Leskovar[2]; Madhumita Joshi[3]; John Jifon[4]; Carlos A. Avila[3]; Joseph G. Masabni[5]; Russell W. Wallace[5] and Kevin Crosby[6], (1)Texas A&M AgriLife Reserach, Texas A&M University, (2)Texas A&M AgriLife Research & Extension Center, Texas A&M University, (3) Texas A&M AgriLife Research, (4)Texas A&M AgriLife Research Center, (5)Texas A&M AgriLife Research & Extension Center, (6)Texas A&M University

With proper rootstock and scion selection, vegetable grafting could ensure improved and stable yield in tomato even in the presence of biotic or abiotic challenges of specific production systems. In this study, grafted and non-grafted tomato treatments as genotype (G) were evaluated in different environments (E) to (i) determine the magnitude of genotype by environment interaction (G × E), and (ii) identify grafted tomato combinations with high stability for yields and yield components across different environments in Texas. Different sets of grafted treatments were included in each trial in the 2017 and 2018 spring seasons. In 2018, the six grafted treatments involved non-grafted tomato cultivars ‘TAMU Hot’ (TAM) and ‘HM1823’ (HM) and grafted on ‘Estamino’ (TAM/ES, HM/ES) and ‘Multifort’ (TAM/MU, HM/MU). Genotypes were tested in eight environments including high tunnel (HT) and open-field (OF) in Lubbock (LU-HT, LU-OF), Overton (OV-HT, OV-OF), Uvalde (UV-HT, UV-OF), and Weslaco (WE-HT, WE-OF). The combined analysis of variance indicated highly significant effects of E, G, and G ×E interaction for total and marketable yields, fruit number per plant and average fruit weight. Environment accounted for 71 to 86% of the total variation in the sum of squares for all these traits, whereas genotype accounted for 4.8 to 10.8%, and G × E for 4.3 to 6.7%. Marketable yield varied from 61.9 to 88.4 Mg ha^{-1} with a grand mean of 73.1 Mg ha^{-1}. HM/MU had the highest marketable yield while HM, TAM and TAM/MU exhibited yield lower than the grand mean. In both seasons, total and marketable yields in OF system across the testing locations were lower than the grand means. LU-OF had the lowest yields while LU-HT and UV-HT exhibited the highest yields. Moreover, higher yields in HT relative to OF were mainly due to significantly higher number of fruits per plant. Based on the univariate and multivariate stability measures, HM/MU for total yield and HM/ES for marketable yield were the most stable graft combination while TAM/ES was very unstable for the yields across test environments. These high-yielding and stable graft treatments could be evaluated further and promoted for a successful integration of grafting technique into current tomato production practices in Texas.

Specified Source(s) of Funding: Texas Vegetable Seed Grant

10:45 AM – 11:00 AM

Adaptability of Fresh-Market Compact Growth-Habit Tomato for Mechanical Harvest and Development of Fertilization Programs to Maximize Yield Potential

Shinsuke Agehara; Tiare Silvasy* and Samuel F. Hutton, University of Florida

With the prospect of labor shortages and mechanical harvesting in the tomato industry future, there is a need for compact growth habit (CGH) varieties and corresponding fertilizer recommendations to be developed for large-green fresh-market tomatoes. The University of Florida breeding program developed Fla. 8924 as a new CGH inbred line with determinate vines and short branches that do not require pruning, staking, or tying. Two experiments were conducted in west central Florida in the spring and fall seasons of 2018 to determine the optimal fertilization program to maximize yield of Fla. 8924 as compared to the commercial standard cultivar, Florida 47. Treatments included four nitrogen (N) fertilization programs and staking vs. no staking. Fertilization treatments were different pre-plant band N (BN) rates (0, 67, 135, and 202 kg/ha) combined with post-planting drip fertigation N (DN) rates (202, 135, 67, and 0 kg/ha). In addition, all treatments received pre-plant incorporation N at 56 kg/ha, providing a total of 258 kg/ha. Fruits on the bed top were harvested one time at the mature green stage in each season. Elimination of staking reduced marketable yield by 38% to 43% for ‘Florida 47’ but only by 0% to 23% for Fla. 8924. Unstaked Fla. 8924 had 82% to 89% of marketable yield of staked ‘Florida 47’, which are above the criteria (equal or greater than 80%) for breeding a tomato line for mechanical harvest. Yield responses to fertilization treatments were different in the two seasons. In both seasons, neither fertilization nor staking treatment had cultivar-specific effects. Marketable yield of unstaked tomatoes was maximized with BN at 202 kg/ha and no DN in the spring season, whereas it was maximized with two fertilization programs that included both BN and DN in the fall season. Our results suggest that Fla. 8924 can achieve, even without staking, high marketable yield competitive to a commercial standard cultivar under the staked production system. Yield of Fla. 8924 can be improved by adopting the optimal fertilization program in each season. More DN with minimal pre-plant N is beneficial in spring, whereas a combination of BN and DN is ideal in fall.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant Program (FAIN#: USDA-AMS-SCBGP-2016)

11:00 AM – 11:15 AM

Economically Optimum Plant Density of Machine-Harvested Edamame

Martin M. Williams II*, USDA-ARS and Daljeet S. Dhaliwal, University of Illinois

Consumer demand for edamame, the vegetable version of soybean, has grown the last decade in North America. Domestic production of edamame is on the rise; however, research to guide fundamental crop production practices is lacking, including knowledge useful for developing appropriate recommendations for crop seeding rate. Field experiments near Urbana, Illinois were used to quantify edamame response to plant density and determine the economically optimum plant density (EOPD) of machine-harvested edamame. Crop growth and yield responses to a range of plant densities (24,700 to 395,100 plants/ha) were quantified in four edamame cultivars (AGS 292, BeSweet 292, Gardensoy 42, and Midori Giant) across two years. Plots were harvested with the Oxbo BH100, a fresh market bean and pea harvester. Assumptions for the economic analysis included a seed cost of $38/kg and wholesale price of frozen podded edamame of $6.60/kg. In general as plant density increased, branching and the ratio of pod mass to vegetative mass decreased, while plant height and leaf area index increased. Recovery, the percent of marketable pods in the machine-harvested sample, varied among cultivars from 86 to 95%. Initial findings identified the EOPD for machine-harvested edamame averaged 88,000 plants/ha, resulting in an average maximum marketable pod yield of 5.2 Mt/ha. When considering seed costs, marketable pod yield, and recovery, edamame EOPDs are considerably lower than recommended seeding rates of up to 344,200 seed/ha observed in some recent publications.

11:15 AM – 11:30 AM

Legacy Effects of Biodegradable Mulch on Vegetable Crop Yield and Soil Properties

Elise Reid*; Sam E. Wortman; M. Benjamin Samuelson; Rhae Drijber and Humberto Blanco, University of Nebraska - Lincoln

Plastic film mulches are often used in horticulture to manage weeds, improve water retention, and increase the soil temperature. Currently, bioplastics and biofabrics are being investigated as sustainable alternatives to plastic film. However, there are few effective biodegradable mulches in compliance with National Organic Program (NOP) certification guidelines. Polylactic acid (PLA) is a 100% biobased polymer (a requirement of the NOP) that could be incorporated into the soil after a field season, unlike bioplastics. However, PLA does degrade slower than other biodegradable polymers, which brings its NOP eligibility into question. A novel biodegradable PLA-based mulch with wood fiber particles embedded in the melt-blown matrix (3M Company; St. Paul, Minnesota, USA) was compared to a MaterBi bioplastic mulch film (Bio360, Dubois Agrinovation; St. Remi, QC, Canada) across two climatically diverse locations (Scottsbluff, NE and Lincoln, NE) in a two-year mulch degradation trial. Five soil amendments which included compost, compost extract, cover crops, fallow irrigation, and a combination of the four (“kitchen sink”) were applied with the goal of accelerating the rate of mulch degradation (and compared to a null control). Our objectives were to determine the individual and combined effects of soil amendment treatments and residual mulch in soil on vegetable crop yield, soil organic matter, macronutrient availability, and soil physical properties. Compost amendment (alone and in “kitchen sink” treatments) increased crop yield by 34%-43%, soil sorptivity up to 18.6%, and macronutrient availability compared to all other treatments at Scottsbluff. Soil incorporation of the PLA-based mulch combined with application of all amendments (“kitchen sink”) increased soil sorptivity by 9.5% at Lincoln compared to the PLA-based mulch with no application. The MaterBi-based mulch lost 91% of its initial mass after 1 yr in Lincoln, whereas the PLA-based mulch lost 63% of its initial mass in 1 yr. The degradation rate was slower at Scottsbluff (semi-arid climate and coarse-textured, low organic matter soil) for the MaterBi-based mulch (32% mass loss) than in Lincoln (humid continental climate and high organic matter soil), but the PLA-based mulch mass loss was similar (67%). Initial results of this study suggest that the effects of biobased mulch residues on soil properties and yield are negligible compared to the effects of compost application; moreover, site-specific conditions and mulch properties are more important drivers of mulch biodegradation than soil management.

11:30 AM – 11:45 AM

Potasium Requirement for the Main Potato Varieties in Columbia Basin of Oregon

Ruijun Qin*, University of California, Davis; Vidyasagar Sathuvalli, Oregon State University; Scott B. Lukas, Oregon State University, HAREC and Mark Pavek, Washington State University

Potato production requires large quantities of potassium (K) especially in the Columbia Basin where the potato-growing season lasts 5-month long. However, the information related to K fertilization for potato production is relatively limited, especially for new potato varieties. Therefore, there is an urgent need to evaluate the nutrient requirements and develop nutrient guidelines for each specific variety, which would help growers achieve optimal potato production with tailored fertilizer rates. From April 25 to October 3, 2018, a field experiment was conducted on Quincy loamy fine sand soil in Boardman, Oregon followed a randomized complete block design with three replicates. The treatments consisted of the combination of six potato varieties (Clearwater Russet, Castle Russet, Umatilla Russet, Alturas Russet, Echo Russet, and Russet Burbank) and five K rates ranging from 0 to 897 kg ha^{-1}. Field observation showed that different potato varieties had a different growth pattern; Alturas Russet had the longest vine followed by Clearwater Russet, while the Echo Russet had the shortest vine followed by Castle Russet. The potato vine was longer in fertilized plots than in the non-fertilized plots. The highest yield occurred at a K rate of 448 kg ha^{-1} for Alturas Russet, Clearwater Russet, and Umatilla Russet, at a K rate of 224 kg ha^{-1} for Russet Burbank, and at a K rate of 672 kg ha^{-1} for Castle Russet and Echo Russet. In general, the tested potatoes had good fry quality meeting to USDA standard No.1. The highest K rate tends to have a better fry quality for Alturas Russet, Castle Russet, and Clearwater Russet, while the fry quality for Echo Russet was consistent regardless of K fertilizer rate. A moderate level of K rates had lower fry quality for Russet Burbank and Umatilla Russet. More data are needed in order to develop variety-specific K recommendations for the main potato varieties in the region.

Marketing and Economics 2

Moderator: Melinda Knuth
Texas A&M University, College Station, TX, USA

2:00 PM – 2:15 PM

An Overview for the Application of Facebook Marketing in Florist Industry-in the Case of Taiwan

Li-Chun Chen, National Taiwan University and Li-Chun Huang*, National Taiwan Univ

Social media are the most widely used new media for consumers today. With the coming of social media era, florists have adopted social media for marketing purposes. However, there are few academic studies to evaluate the results of the adoption of social media marketing in the florist industry. It results in the difficulty of developing appropriate strategies to enhance the efficiency of social media marketing for florists. To address the deficiency, this study aimed to explore: (1) the motivation for florists to adopt social media marketing; 2) the efficacy perceived by florists as adopting social media in their business operations; 3) the obstacles for florists in the adoption of social media marketing. Data were collected from the depth interviews with fourteen managers who have been operating Facebook fan pages for their floral shops. The study results indicated that the motivations for the florists to adopt social media were: 1) adapting to consumers' social media usage trends, 2) increasing the exposure of the flower shops, and 3) demonstrating the floral creation ability of the flower shops. In addition, the most experienced use benefits of social media marketing for florists were: 1) developing new customers, and 2) enhancing corporate image. However, florists were facing the obstacle of resource incapacity and fans' disloyalty in their Facebook fan page operations. Based on the study results, we suggest that florists should develop promotion strategies to increase fans' engagements to florists' Facebook fan pages.

2:15 PM – 2:30 PM

Sign Complexity of Garden and Retail Center Signs

Melinda Knuth*[1]; Bridget K. Behe[2]; Patricia Huddleston[2] and Charles R. Hall[1], (1)Texas A&M University, (2)Michigan State University

Retail and garden center signage is intended to deliver information about products and messaging from the company to facilitate purchases. Yet, how much information is helpful for consumers versus overwhelming? Our objectives were to understand what level of sign complexity encourages consumers to buy products from the display. We hypothesized that consumers would prefer moderately complex signs over highly complex and low-complexity signs because highly complex signs are more challenging to cognitively process and low-complexity signs may be too simple and lack sufficient information. Three individuals rated 45 signs as low, moderate, or highly complex (Wedel and Pieters (2008) and selected 15 (5 from each category) after examining the mean ratings. Images were randomized and incorporated into the Tobii X1 Light Eye Tracker software where 85 subjects were asked to rate the attractiveness (0-7 scale) and likeliness to buy (0-10 scale). After the eye-tacking portion of the study, subjects completed a sociodemographic survey which also included scales measuring Landscape Active Use and Aesthetics, Plant Involvement and Expertise, and Attractiveness Scales. Results showedcomplexity was a predictor of how attractive the participants rated the signs. Highly complex signs were most preferred, followed by moderately complex, and low-complexity signs as least preferred. Sign complexity and Real Knowledge of plants were the only predictors of Likelihood to Buy. Results may be due to the need for more information about the plants that cannot be gleaned simply by looking at the plants. Information-rich messaging in high complexity signs may give consumers sufficient information to make a purchase, despite the higher cognitive processing needed.

Specified Source(s) of Funding: Metro-Detroit Flower Growers Association

2:30 PM – 2:45 PM

Produce Buyer Quality Requirements to Form an Eastern Broccoli Industry

Phillip Coles*[1]; Jiayi Carol Dong[2]; Miguel Gómez[3] and Thomas Björkman[3], (1)Lehigh University, (2)University of California Davis, (3)Cornell University

ABSTRACT

The USDA funded the East Coast Broccoli Project in order to diversify the highly concentrated supply of broccoli and establish a scalable supply chain along the East Coast. New varieties have been developed to grow in the East Coast climate and previous research has demonstrated promising consumer demand for locally grown broccoli among East Coast consumers. However, understanding of retail buyer preferences is decidedly limited. This study fills the gap and explores wholesale and retail buyer, broccoli procurement quality requirements, their assessment on local and non-local broccoli, and heterogeneity in preferences among them. An online survey was conducted with twenty-seven buyers along the East Coast covering approximately half of the retail landscape. In the survey, the buyers expressed strong preference for dark green color, small bead size, uniform beads and heads, and short stem length when procuring broccoli. Although they would prefer local broccoli to those from the West Coast, everything else being equal, they demand the same quality for the local broccoli. Therefore, to compete with West Coast broccoli, East Coast growers must first ensure product quality. Natural food resellers were found to be relatively more open to different product conditions and believe that local broccoli could command a price premium. They could be the most approachable buyers for the new broccoli producers and a promising marketing channel to develop the East Coast broccoli industry.

Keywords: broccoli, local food, buyer preferences, logit regression

Specified Source(s) of Funding: This work is supported by Specialty Crop Research Initiative grants No. 2016-51181-25402 and 2010-51181-21062 from the USDA National Institute of Food and Agriculture.

2:45 PM – 3:00 PM

Young Industry Professionals' Identified Current

Trends and Confidence in the Future of the Horticulture Industry

Caroline Warwick[1]; Angela Colonna[*2]; Liz Felter[1]; Roger Kjelgren[1] and Tracy Irani[1], (1)University of Florida, (2)UF/IFAS Mid-Florida Research and Education Center

With the impending retirement of "Baby Boomers," the horticultural industry is preparing for a generational shift in owners/operators and nursery employees. Understanding the confidence of the next generation of young industry professionals, identified by researchers as under 40 years old, as well as current trends they are observing in horticulture, serves an important role in identifying ways university researchers and Extension faculty can better serve them. The objective of this research was to understand young industry professionals' confidence in the future of the horticulture industry as well as identify any current trends they are observing. Focus group research is a commonly used quantitative research method that allows researchers to have a better depth of understanding of participants' opinions. During the focus groups, participants were asked specific questions about their perceptions of the future of the horticulture industry and any trends, either positive or negative, that they are observing in the industry. Data was analyzed using the constant comparative method in MAXQDA2018 after the focus groups were audio recorded and transcribed. Researchers found that young industry professionals are confident in the future of their industry, however, they are not immune to many of the pressures associated with urbanization – skyrocketing property values and increased complaints and conflict with neighbors over land use and production practices. Many participants involved in food systems discussed the enthusiasm that many urbanites have for food production as a boost in confidence, but cited pressures due to urbanization, especially in the affordability of space in urban areas, as a negative trend affecting new producers. Young industry professionals also identified negative trends associated with the changing labor market, as finding qualified laborers and college graduates with horticulture degrees is becoming more and more difficult. Participants also discussed the impact of transitioning to the new generation of horticulturalists, as many operations are being sold due to family members not wanting to continue working in the industry. These findings can be used to guide university horticulture departments, who can work to improve the connection between academia and industry, working with independent growers and industry groups to promote careers in horticulture. Additionally, these results can be used by researchers, who could conduct studies to better understand pressures faced by producers in increasingly urban environments. These findings can also be used to guide new Extension employees in the areas of food systems or production horticulture to help them understand the current state of the industry.

3:00 PM – 3:15 PM

Vidalia Onion Buyer Knowledge of Growing Location

Hannah Miller*; Ben Campbell; Julie Campbell and Vanessa Shonkwiler, University of Georgia

Vidalia sweet onions are one of the largest crops in Georgia. However, Vidalia onions can only be grown in several counties within Georgia which limits the location of production. Much of the Vidalia marketing is associated with the great taste of the sweet onions due to the specific growing region. However, little is known about consumer understanding of where Vidalia onions are grown. This is critical as a large amount of resources are spent advertising and promoting the product of Georgia geographic origin. In order to assess consumer knowledge about Vidalia onions we surveyed consumers throughout the U.S. using an online survey of 1,500 consumers. Results indicated that respondents in Georgia were aware of the products origin, while respondents in states farther from Georgia were less likely to know Vidalia onions are only grown in Georgia with many respondents prescribing production to be throughout the U.S. As such, efforts to promote Vidalia onions as from Georgia is not resonating with many consumers, especially those farther away from Georgia. Thereby, producers and industry stakeholders should reassess their marketing strategies to either focus on other Vidalia onion characteristics or find new ways to raise awareness that Vidalia onions are grown in Georgia.

Pomology 2

Moderator: Gregory Peck
Cornell University, Ithaca, NY, USA

2:00 PM – 2:15 PM

Temporal and Spatial Changes in the Methylation Profile of *MdKRP4* and *MdKRP5*

Bayleigh Roussel*, University of Georgia

Apple (*Malus x domestica*) is a pome where the fruit consists of two main sections: the cortex and the pith. The true ovary of the fruit is within the pith and is not consumed. The cortex enlarges and develops into the major fleshy part of the fruit that is consumed. Cortex enlargement occurs at a rate much greater than that of the pith. Two genes that may influence the final size of the two tissues are *KIP RELATED PROTEIN* 4 (*KRP4)* and *KRP5*. KRPs are cyclin-dependent kinase inhibitors and negatively regulate the checkpoints in between phases of the cell cycle and thereby negatively affect the extent of cell production. Transcript abundance of these genes is low during the cell production phase within the first five weeks of fruit growth. After about five weeks, cells begin to expand and the transcript abundance of these genes begins to increase concomitant with the reduction in cell production. Further, KRP4 transcript abundance is substantially greater within the pith than in the cortex during early fruit growth, consistent with lower cell production in this tissue. Regulation of such spatio-temporal changes in transcript abundance of these genes is currently unknown.

We hypothesize that promoter methylation of *KRP4* and *KRP5* is involved in differential spatial and temporal transcript accumulation of these genes. Hence, methylation in the promoters of *KRP4* and *KRP5* is being studied. Previous reports indicate specific regions within the promoters of these genes that are subject to methylation. To better understand methylation patterns, apple fruit tissue is being collected throughout fruit development, specifically from the pith and cortex tissues. Sample DNA will be extracted, treated with bisulfite, and analyzed using the Kismeth program to understand how *KRP4* and *KRP5* methylation patterns change over time and space. A callus system is also being developed to study methylation *in vitro*, as transcript accumulation patterns can change depending on growth conditions. Leaf tissue from four cultivars ('Gala,' 'Honeycrisp,' 'Empire,' and 'Golden Delicious') are being used to develop a callus culture. The most productive callus will then be placed in suspension solutions to facilitate the growth of the undifferentiated cells. Using a combination of *in vitro* and field grown samples, we will be able to get a more complete understanding of methylation in the promoters of *KRP4* and *KRP5* and its association with organ growth.

2:15 PM – 2:30 PM

Diversity of Cider Apple Germplasm in the United States

Gregory Michael Peck*; David L. Zakalik and Michael G. Brown, Cornell University

Specialized cider apples (*Malus xdomestica* Borkh.) contain quality attributes that provide important and noteworthy characteristics to finished cider, including bitterness and astringency (naturally provided through a sub-group of polyphenolic compounds called "tannins"), sharpness (naturally provided through organic acids, predominantly malic acid), sweetness (naturally provided through sugars and sugar-alcohols, such as sorbitol), and flavors (naturally provided through volatile aromatic compounds). In regions with long-standing traditions of cider production, numerous apple cultivars have been cultivated over the centuries. For example, the Herefordshire Pomona, which was published late 1800's, lists more than 80 cider apple cultivars. More recent pomonas list 160 cider apple cultivars being grown in the cider producing counties in Western England and 300 in France. Even greater levels of diversity can be found in the cider producing regions of Spain, where more than 400 cider cultivars have been identified. To gain a greater understanding of the diversity of cider apples available in the United States, we have identified and analyzed 269 genotypes in the United States Department of Agriculture-Plant Genetic Resources Unit (USDA-PGRU) *Malus* germplasm collection in Geneva, NY. Our goal is to categorize genotypes that have desirable and perhaps unique juice quality, but that are also productive in modern orchard systems. France, the United States, and the United Kingdom each represent about 25% of our sample set with the remaining accessions originating from 21 other countries. As measured by the Folin-Ciocalteu assay, total polyphenols in the apple juice samples from these accessions had a nearly 50-fold difference in concentration (0.1-4.86 $g \cdot L^{-1}$). Other important juice characteristics ranged greatly among genotypes and between years: soluble solid concentration (12.4; 2.8- 21.5 °Brix), titratable acidity (4.79; 0.26-22.9 $g \cdot L^{-1}$), sucrose (54.4; 0-163 $g \cdot L^{-1}$), glucose (31.1; 3.8-120.1 $g \cdot L^{-1}$), fructose (100.7; 11.5-202.4 $g \cdot L^{-1}$), and sorbitol (10; 0.3-49.3 $g \cdot L^{-1}$). While greater diversity is beneficial from the standpoint of maintaining genetic resources and creating unique cider styles, it can be a challenge to new cider producers and apple tree nurseries to identify cultivars with the greatest chance for success in a given region. For this reason, our results should aid in determining genotypes to include in future cultivar evaluations.

Specified Source(s) of Funding: USDA-Hatch and New York State Department of Agriculture and Markets

2:30 PM – 2:45 PM

Suitability and Efficacy of Chemicals for Apple Blossom Thinning

Sherif Sherif*; Chester Allen and Keith Yoder, Virginia Tech

The profitability of apple fruit producers is mainly dependent upon the consistent, high annual yield of quality fruit. In commercial apple production systems, this cannot be achieved without effective crop load management strategies that make a balance between vegetative and fruiting buds, reduce fruit-to-fruit competition, allow fruit enough room to grow, expose fruit to adequate sunlight and enhance return bloom. It is already well-established that crop thinning during bloom produces the largest fruit, the highest return bloom and reduces biennial bearing. However, our knowledge of chemicals and conditions that achieve efficient thinning at bloom stage is still limited, especially in the Eastern US. The objective of the present study was to evaluate materials for chemical blooms thinning that can achieve proper thinning activity without having negative impacts on fruit quality. To this end, we assessed the thinning efficacy of five chemicals including ammonium thiosulfate (ATS), potassium thiosulfate (KTS), lime sulfur, Regalia and potassium bicarbonate. All materials were applied alone or in combination with JMS Stylet-Oil to mature 'Honeycrisp' and 'Pink Lady' trees in 2018 and 2019 growing seasons, using a backpack sprayer. The timing of thinning treatments was determined according to the pollen tube growth model (PTGM). The experiment was arranged in a completely randomized design (CRD). No post-bloom chemical thinning applications or hand thinning were applied to the examined blocks. Fruit set (%) data were recorded after two, four and six weeks of the first thinning application; and at harvest (for the 2018 season). Our results indicated the following: a) ATS and KTS at low concentrations (1 % and 0.5%, respectively) did not cause fruit russets, but their thinning efficiencies were too low, b) Potassium bicarbonate was a potent blossom thinner; however, lower concentrations should be considered to keep crop losses due to russet at a minimum, c) Potassium bicarbonate-oil mix caused severe damages to fruit and apple foliage, d) Low concentrations of lime sulfur (1%) did not cause fruit injury; however higher concentrations should be considered for better thinning results, e) Thinning applications combining Regalia and oil showed promising results, and f) thinning materials showed minimal impacts on the physical (fruit color, firmness, diameter and mass) and chemical (fruit starch index, titertable acidity, soluble solid content and pH) properties of the 'Honeycrisp' and 'Pink Lady' apples.

Specified Source(s) of Funding: VIRGINIA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES

2:45 PM – 3:00 PM

The Impact of Time and Level of Fruit Thinning and Rootstock on Leaf and Fruit Mineral Status and Fruit Quality in 'Honeycrisp' Apple

Esmaeil Fallahi*; Bahar Fallahi and Michael Kiester, University of Idaho Parma Research and Extension Center

'Honeycrisp' is an extremely popular apple, but is susceptible to certain disorders, mainly bitter pit. The impact of different levels of fruit thinning at two stages of fruit growth on yield, fruit quality, and seasonal leaf and fruit mineral nutrients and the influence of five rootstocks on fruit quality at harvest and after storage and fruit quality attributes and final leaf and fruit mineral status were studied over two seasons. Early and late thinning of fruit down to one fruit per spur reduced fruit firmness but increased fruit size, color, and bitter pit compared to the lighter thinning levels in both years. It appeared that early thinning would lead to larger fruit size with less bitter pit than late thinning. Thinning influenced mineral nutrient fluctuations in leaf and fruit. Most of the leaf and fruit mineral concentrations decreased in all thinning treatments as the growing season progressed. Trees on G.30 and V.1 rootstocks had lower firmness in both 2017 and 2018. Trees from G.202 rootstocks tended to have lower yield and smaller fruit size, leading to higher firmness in both 2017 and 2018. Trees on M.26 EMLA had higher but those on G.202 had lower leaf N, Mg, Mn and fruit N, leading to better color in the scion fruit with G.202 in one year. The magnetite of fruit Mg in trees on G.969 and G.202 were opposite to their fruit Ca. Analyses of different tissues revealed that fruit skin in the calyx end and wedges had higher Ca and lower K/Ca ratio than did other tissues. There was a significant and strong correlation coefficient between Ca concentrations of calyx end skin plus skin flesh and bitter pit, and thus calyx end could be a preferred tissue for detection of Ca status and bitter pit disorder in 'Honeycrisp' apples.

3:00 PM – 3:15 PM

Ethylene Evolution of Flowers of Different Apple Cultivars Varies in Timing and Intensity

Poliana Francescatto[1]; Bruno Carra[2]; Guilherme Fontanella[3] and Terence Lee Robinson*[1], (1)Cornell University, (2)Universidade Federal de Pelotas - UFPEL, (3)Cornell Universtiy

Fruit set of some apple cultivars is low despite abundant flowering. This could be due to high ethylene production of the flowers, poor receptivity of the stigmas and or short ovule longevity. The ethylene synthesis inhibitor aminoethoxyvinylglicine (AVG) is known to reversibly inhibit the activity of the enzyme 1-aminocyclopropane-l-carboxylic acid (ACC) synthase. ACC is a directly precursor of ethylene. The objective of this study was to investigate ethylene evolution of different apple varieties during early flowering and fruit set under the climatic conditions of New York state and, furthermore, understand the effect of AVG on ethylene evolution and consequently, fruit set. We harvested flowers/fruitlets every three days from 2 days before full bloom until 18 days after full bloom of 4 apple cultivars (Gala, Fuji, Honeycrisp and Minneiska). The flowers/fruitlets were placed into a sealed container for 4 hours and a gas sample of the headspace was analyzed by gas chromatography for ethylene production. 'Gala', 'Fuji' and 'Honeycrisp' had low levels of ethylene production over the measurement period, but each had a distinct peak of production of about 3.5 $\mu L\ L^{-1}h^{-1}$. 'Gala' had the earliest peak at 2 days after full bloom while 'Fuji's' peak was about 4 days after bloom and 'Honeycrisp's' peak was about 7 days after bloom. For each cultivar the ethylene peak was short lived and dropped to low levels within 4 days of the peak. In contrast Minneiska had a much greater level of ethylene production than the other cultivars reaching 8 $\mu L\ L^{-1}h^{-1}$ at its peak. The level of flower produced ethylene rose above the level of other cultivars by day 4 after full bloom and reached a peak at 8-9 days after full bloom then dropping to the level of the other cultivars by day 12 after full bloom. This high and sustained level of ethylene may be the cause of the lower set of Minneiska compared to the other 3 cultivars. In a related study we applied AVG, at bloom, petal fall and 12mm fruit size to Minneiska flowers/fruitlets. At the bloom and petal fall timing AVG reduced flower ethylene evolution in a rate dependent manner. At 12mm fruit size there was no effect of AVG since fruitlet ethylene level was very low at that time. Due to the higher ethylene level in Minneiska flowers/fruitlets compared to the other cultivars we studied and its typically low fruit set, our results suggest that AVG could be a potential tool to overcome high ethylene production and low fruit set issues in Minneiska apples in order to help apple growers achieve greater yields and profits.

Specified Source(s) of Funding: Partial funding for this work was from the NY Apple Research and Development Program

Temperate Tree Nut Crops

Moderator: Megan Muehlbauer
Rutgers University, New Brunswick, NJ, United States

2:00 PM – 2:15 PM

High Throughput Phenotyping of UCB-1 (*Pistacia atlantica* x *P. integerrima*) Seedling Rootstocks in Experimental Pistachio Orchard

Ewelina Jacygrad*[1]; Sean Hogan[2]; Alireza Pourreza[3]; John E Preece[4]; William J. Palmer[5]; Richard Michelmore[6] and Deborah Golino[1], (1)Foundation Plant Services, UC Davis, (2) Division of Agriculture and Natural Resources, UC Davis, (3)Department of Biological and Agricultural Engineering, UC Davis, (4)National Clonal Germplasm Repository USDA-ARS, (5)Genome Center, UC Davis, (6)University of California, Davis

‘UCB-1’ is currently the most commonly used pistachio rootstock in California but it varies because it is a population of F1 seedlings from a cross between two heterozygous outbreeding species. Phenotyping of large orchard populations is labor inefficient and expensive. High-throughput phenotyping (HTP) using drones allows analysis of many genotypes in multiple locations. A DJI Matrice 100 drone, equipped with both a conventional DJI X3 12 MP red-green-blue (RGB) camera and a Micasense RedEdge multispectral (blue, green, red, red edge, and near infrared) imager was flown over a 3.5 acre experimental pistachio orchard at UC Davis’s Russell Ranch multiple times during 2018. Tree height and canopy volume of 480 five year old UCB-1 seedlings were recorded. These flights were conducted at an altitude of 30 meters above ground level, using a pre-planned crosshatched (grid) autonomous flight plan, with the cameras set to trigger along the drone’s path such that each picture would have an approximately 90% overlap with each adjacent picture. The resulting RGB orthomosaics were found to have a spatial resolution (ground sample distance) of approximately 1.5 cm, and the multispectral imagery a spatial resolution of 1.8 cm. This HTP reduced measurement error and facilitated the determination of dynamic traits such as tree height and canopy volume.

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Specified Source(s) of Funding: California Pistachio Research Board

2:15 PM – 2:30 PM

Effect of *Pistacia* rootstock and Mechanical Pruning Timing on Alternate Bearing

Robert Beede, University of California Cooperative Extension and Louise Ferguson*, University of California, Davis

A six year trial, three alternate bearing cycles, trial investigated the effect of timing of mechanical topping and hedging on alternate bering in *Pistacia vera* cv. ‘Kerman’ female tree on four different rootstocks; *P. atlantica, P. integerrima, P. atlantica X P. integerrima, P. integerrima x P. atlantica.* Results demonstrated that both yield and alternate bearing were affected by rootstock. Trees on *P. atlantica, P. integerrima, P. atlantica X P.* integerrima, and *P. integerrima x P. atlantica* produced an average of 3823, 4641, 5433 and 5634 annual pounds per acre respectively. As demonstrated in an earlier trial alternate bearing of trees on a *P. atlantica r*ootstock was more effectively mitigated by mechanical topping and hedging entering a low crop year versus a high crop year; the respective alternate bearing indexes in this trial were 0.41 and 0.79. The same treatment was equally effective on the less alternate bearing trees on the *P. integerrima* rootstocks; mechanical topping and hedging entering a low crop year versus a high crop year produced alternate bearing indexes of 0.21 versus 0.55. For ‘Kerman’ trees on the *P. integerrima, P. atlantica X P. integerrima,* and the P. *integerrima x P. atlantica* hybrid rootstocks the alternate bearing indexes were significantly lower than on single species rootstocks, virtually identical and unaffected by mechanical topping hedging entering the high or low crop year. The ‘Kerman’ scion on the P. *integerrima x P. atlantica* hybrid rootstock had an alternate bearing index of 0.27 when pruned entering both the high and low crop year. The ‘Kerman’ scion on the *P. atlantica X P. integerrima* rootstock has an alternate bearing index of 0.29 if topped and hedged prior to the low crop year and 0.30 if pruned entering the high crop year. The results demonstrate that that the current commercial rootstocks in California not only have a significant effect on both yield and alternate bearing of the ‘Kerman’ female scion but also produce significantly different reactions to mechanical topping. It appears the vigor of the *P. integerrima* parent confers the ability to decrease alternate bearing.

Specified Source(s) of Funding: California Pistachio Research Board

2:30 PM – 2:45 PM

Evaluating American Hazelnuts for Use As Cold Hardy Pollenizers in European Hazelnut Orchards

Alex Mayberry*[1]; John Michael Capik[1]; Shawn A Mehlenbacher[2] and Thomas J. Molnar[1], (1)Rutgers University, (2) Oregon State University

New disease-resistant hazelnut cultivars should allow for European hazelnut (*Corylus avellana*) production in the northeastern U.S. where eastern filbert blight (EFB) previously prevented the establishment of a commercial industry. While these EFB-resistant cultivars are adapted to a wide area, their male flowers (catkins) can be damaged by mid-winter cold in some regions, limiting the amount of pollen shed and reducing nut yields. Female flowers are considerably more cold-hardy, but elongated catkins are quite tender. Fortunately, the wild American hazelnut (*Corylus americana*), native to the eastern half of the United States and parts of southern Canada, is cross-compatible with the European hazelnut and is much less susceptible to catkin cold injury. However, female receptivity and pollen shed times differ between the species, and among selections within each species, and the incompatibly alleles of *C. americana* selections have not been identified. In this

study, we investigated the feasibility of using American hazelnut selections as pollenizers for European hazelnut orchards. Previous work at Rutgers University identified selections of EFB-resistant, cold-hardy, American hazelnuts with large numbers of catkins and a range of pollen shedding times that spanned most of the pistillate flower receptivity period of the European hazelnut. A geographically diverse subset of these *C. americana* selections (n=15) were used in controlled crosses with diverse selections of *C. avellana.* Hazelnuts show sporophytic incompatibility, which is controlled by a single locus with 33 known alleles. Incompatibility testing was performed using fluorescence microscopy. Pollen collected from the American selections was evaluated for viability and used in controlled crosses on replicated clones of *C. avellana*, with *C. avellana* pollens used as controls for comparison. The percentage of cluster set (ratio of nuts set to females pollinated) was calculated for each pollen parent, and the physical appearance and defect percentages for each pollen source were noted for each female parent. These data, in combination with flowering phenology notes, identified S-alleles, and pollen viability data, will help determine the feasibility of American hazelnut selections as pollenizers in European hazelnut orchards, and possibly identify superior clones for this purpose for the emerging industry.

Specified Source(s) of Funding: Northeast SARE

2:45 PM – 3:00 PM

In Vitro Protocol for Evaluating Bacterial Blight Susceptibility of New Hazelnut Cultivars

J. Bryan Webber* and Nik G. Wiman, Oregon State University

Bacterial blight (*Xanthomonas arboricola* pv. *corylina* (*Xac*)) of hazelnut (*Corylus avellana* L.) was described first in Oregon in 1915 and is now recognized as a damaging disease of young hazelnut trees worldwide. Thousands of acres of new hazelnut cultivars are being planted in the Willamette Valley of Oregon where 99 percent of the US hazelnut crop is grown. There has been an increased incidence of bacterial blight in young hazelnut plantings and no quantitative research on bacterial blight susceptibility in the different hazelnut cultivars. Increased nursery production of hazelnut trees to meet the rising demand has been made possible through the development of the 2016 *Corylus* tissue culture medium optimized for hazelnut growth. In this study, tissue culture was used as a controlled environment to investigate the potential for developing a rapid screening technique to determine cultivar relative susceptibility to bacterial blight infection. Culture medium, stress conditions, and disease symptom progression were evaluated to analyze the response of hazelnut explants in culture tubes to bacterial blight inoculation. The bacteria were found to proliferate on the 2016 *Corylus* media, so explants were transferred to inert media for the duration of the evaluation. Infection symptoms consistent with those seen in the field such as leaf lesions, leaf chlorosis, leaf and shoot necrosis along with characteristic bacterial ooze were observed in inoculated hazelnut explants within two weeks. No significant differences in relative susceptibility of cultivars was detected, as each of the five cultivars displayed symptoms similar in rate and severity over the course of evaluation. Each of the five cultivars had been reported to succumb to bacterial blight infection under field conditions. The in vitro protocol reduced variability due to the environment, and saved considerable space and time compared to conventional pathogen screening using potted trees or field inoculations. Tissue culture as a technique for rapid screening and understanding disease progression and symptomology was demonstrated in bacterial blight susceptible hazelnut cultivars over time.

3:00 PM – 3:15 PM

Evaluation and Correlation of Kernel Characteristics and Eastern Filbert Blight Response to Genetic Backgrounds of Hazelnut Germplasm from Turkey and the Baltic Region

Megan Muehlbauer*; Thomas J. Molnar; Josh Honig and John Michael Capik, Rutgers University

Eastern Filbert Blight (EFB) is a fungal disease caused by *Anisogramma anomala* and is the primary limitation to commercial hazelnut production in the Eastern United States. Controlling this disease is difficult because not only are fungicide sprays costly, but they are often ineffective against this pathogen. Therefore, breeding for resistance is the best long-term control method to combat the destructive EFB. In order to undertake this project, a pool of genetically diverse germplasm was obtained. The purpose of this diverse pool for the project was to evaluate a large collection of hazelnut seedlings for their individual resistance to EFB, commercially acceptable kernel characteristics, and subsequently correlate this information to the genetic backgrounds of the seedlings to create a referential knowledge base of informed breeding decisions. In 2004/2005, 855 open-pollinated hazelnut seeds were collected from Turkey, Latvia, and Lithuania. After over 10 years of their being exposed to *A. anomala* both in humidity chambers and in the field, 24 accessions were shown to have resistance or tolerance to EFB. After 5 years of nut evaluations, including percentage shell, kernel weight and kernel sphericity, and blanching, nearly all 24 accessions showed diverse, albeit commercially acceptable quality. Concurrently, the 24 accessions were genetically fingerprinted using simple sequence repeat (SSR) markers to determine their genetic similarity to each other, as well as to previously characterized cultivars and accessions. Only four of the 24 accessions were found to be over 50% genetically similar to previously characterized accessions/cultivars. The majority of the new EFB resistant/tolerant plants with relatively good nut quality and genetically unique backgrounds are potentially highly valuable additions to the U.S. hazelnut breeding programs.

Growth Chambers and Controlled Environments 4

Moderator: Qingwu Meng
Michigan State University, East Lansing, MI, USA

2:00 PM – 2:15 PM

Commercial Feasibility of Monochromatic Light Treatments in Controlled Environments for Manipulating Plant Morphology and Yield

Brian Poel* and Melanie Yelton, LumiGrow Inc.

Historical experiments using monochromatic light from light-emitting diodes (LEDs) generally concluded that plants grown under red (R) or blue (B) light alone results in abnormal growth or decreased yield metrics. However, recent research focusing on applying monochromatic R or B as part of a dynamic lighting strategy has shown some promise by means of increasing leaf area and net assimilation rate to increase overall growth. Therefore, there is a potential to apply similar treatments as part of standard commercial lighting programs to increase early-phase canopy growth or total crop photosynthesis to achieve increased production. Applying academic research, especially sole-source experiments, to commercial applications does not necessarily yield projected results, either through influence of solar radiation in a greenhouse or limitations of lighting apparatus for delivering lighting treatments among other challenges. Compared to standard commercial lighting programs, applying monochromatic R or B light treatments as either end-of-day or alternating 12-hour periods showed variable results across multiple crops including *Lactuca sativa*, *Solanum lycopersicum*, and *Cannabis sativa*. Continued investigation of the underlying processes to increase plant production will be necessary at both the commercial and academic level.

2:15 PM – 2:30 PM

Far-Red Photons Are Necessary for Efficient Photosynthesis: Whole-Canopy Photosynthesis and Radiation Capture

Shuyang Zhen* and Bruce Bugbee, Utah State University

Researchers have sought to characterize the effect of light quality on photosynthesis for nearly a century. Early studies used prisms to create monochromatic light and concluded that far-red photons (greater than 700 nm) resulted in minimal photosynthesis. Recent studies have found that far-red photons act synergistically with photons of shorter wavelengths to increase leaf photochemical efficiency and photosynthetic rate. However, the effects on whole-plant photosynthesis have not been characterized. Using a whole-plant gas exchange system, we quantified whole-plant photosynthetic responses of 16 C_3 and two C_4 crop species, to the addition of far-red to a cool white LED light. Our results showed that on incident light basis, adding 701-750 nm far-red photons (10 to 30% of total photon flux) caused similar increase in whole canopy photosynthesis as adding the same amount of 400-700 nm photons. Photosynthesis under far-red alone, however, was less than 20% of that under the same photon flux of 400-700 nm photons. This indicates that far-red photons are equally efficient at driving photosynthesis when act synergistically with traditionally defined photosynthetic photons (400-700 nm). To demonstrate proof of concept, we grew lettuce under light spectra with or without 15% of far-red photons, where all light treatments received equal total photon flux within 400-750nm and should elicit equal photosynthetic rate of the same plant canopy. Percent ground cover, which closely correlates with radiation capture, was measured daily in addition to photosynthesis. At harvest, dry biomass of lettuce was 35% higher in treatments with far-red photons, which was almost entirely caused by enhanced radiation capture through leaf expansion. Our data indicate that far-red photons not only directly increase whole canopy photosynthesis, but also induce leaf expansion and promote canopy radiation capture, thus indirectly increasing plant growth during long-term cultivation. In conclusion, far-red photons are far more valuable than previously thought and should be included as photosynthetically active radiation.

Specified Source(s) of Funding: NASA

2:30 PM – 2:45 PM

The Affect of Heat Stress on Greenhouse Grown Maize Pollen

Brian Krug*; Robyn Ball and James Llewellyn, Corteva

To support research efforts within Corteva Agriscience maize plants are grown in a greenhouse in Johnston, Iowa during all 12 months of the year. Historically, during the summer months, kernel set has been below the desired standard. It had been thought that heat stress was a major factor due to the limited cooling capacity in the greenhouses from June through August. However, the exact parameters that influenced the observed poor kernel set was unknown. The objective of this study was to determine if temporary heat stress at different developmental stages had a negative effect on pollen or silk viability.

Maize plants from two different inbred lines were grown at day/night temperature set points of 78/68 °F. Plants were subjected to a heat stress treatment at 10 different developmental stages (V5, V6, V7, V8, V9, V10, V11, V12, R1, or R2) for a period of 7-d. The heat treatment was applied in a growth chamber with day/night temperature setpoints of 95/79 °F (average daily temp = 89.6 °F) and a 16-hr photoperiod. The experiment was replicated twice over two growth chambers with five single plant replicates per treatment in each treatment replicate. An untreated control was also included. After exposure to the heat stress treatment, plants were placed back into a greenhouse at the original setpoints.

To determine pollen viability, the pollen from treated plants was used to pollinate plants that did not experience a heat stress (untreated silk donors). To determine silk viability, treated plants were pollinated using pollen from untreated plants (untreated pollen donors). First silk emergence, first pollen shed and pollination dates were recorded for each plant. At the end of the study kernel count was estimated.

There was a clear trend for both genotypes that pollen viability is negatively affected when plants are heat stressed for 7 consecutive days at the temperatures tested. Kernel set for both inbreds was negatively affected when stressed at developmental stages V9-V12. Silk viability for only one of the inbreds significantly affected kernel set when heat stressed at developmental stages V9 and V10.

2:45 PM – 3:00 PM

Chlorophyll Fluorescence Imaging: A Novel, Simple and Non-Destructive Method for Canopy Size Imaging

Mangalam Narayanan; Marc W. van Iersel* and Mark Haidekker, University of Georgia

Non-destructive methods to quantify crop growth can provide a valuable tool in both research and production settings. Quantifying canopy size can be done using a variety of imaging techniques, with regular color (red/green/blue, RGB) imaging being the most common approach. However, separating canopy from background is not always easy using RGB imaging and different methods may be needed depending on the background in the image or the color of the leaves. To circumvent this issue, we developed an imaging approach that takes advantage to the fluorescence emitted by chlorophyll. The energy of about 1 to 3% of photons absorbed by leaves is re-emitted as photons in the range of ~690 to 740 nm. This fluorescence coming from plants is easy to photograph: plants are exposed to blue light and images are taken using a monochrome camera with a 680 nm long-pass filter (i.e., only photons with wavelengths > 680 nm can pass through the filter). This assures that the camera can only detect fluorescence from chlorophyll. One complication is that the chlorophyll in algae fluoresces similar to that in plants, so image processing may be needed to separate algae from leaves. This can be achieved by comparing images collected under both blue and white light: algae are more pronounced under blue than under white light. Alternatively, algicides have proven effective in suppressing algae without harmful effects on plants. Comparisons of leaf area measurements using the fluorescence imaging versus a leaf area meter indicate that the fluorescence imaging is almost perfectly correlated with standard leaf area measurements ($R^2 = 0.998$). Chlorophyll fluorescence imaging can also be used to monitor ripening of fruits that contain chlorophyll in their unripe state. The decrease in fruit chlorophyll levels during ripening is easily quantified using this approach. The hardware costs for a chlorophyll imaging system are ~$1,000 and the system is easy to assemble.

Specified Source(s) of Funding: This project was funded by USDA-NIFA-SCRI Award Number #: 2018-51181-28365, project Lighting Approaches to Maximize Profits

3:00 PM – 3:15 PM

Supplemental Light Monitoring in a Three-Story Greenhouse

Karen Panter*[1]; Evan Panter[2] and Samantha Nobes[1], (1) University of Wyoming, (2)Pangolin Landscape

In 2017 a 3-story greenhouse in Wyoming became the site of a year-long light monitoring study. The operation began production of lettuce (*Lactuca sativa* L.) and tomatoes (*Solanum lycopersicum* L.) in spring 2016. Working with faculty and students at the University of Wyoming and Colorado State University, greenhouse management and investors provided funding for a year-long project to monitor light levels in the greenhouse. We purchased six Li-Cor LI-1500 data loggers and 12 Li-Cor LI-190R quantum sensors, two for each data logger, in fall 2017. One data logger with sensors was installed on the upper third floor of the greenhouse in each of the two tomato-growing sections. One sensor was placed near the south side glass in each section while the other was placed on top of an environmental control box on the north wall of each section. The other four data loggers and sensor combinations were placed on individual moving carousels on the middle second floor of the greenhouse. These data loggers and sensors were placed on troughs where lettuce plants would normally be growing. The logger was placed in the middle of one trough on each carousel while the two quantum sensors were placed about 3 feet away on either side of the data logger. We were thus able to quantify the light plants were receiving as they moved on each of the four carousels. Data were logged at 15-minute intervals and daily light integrals (DLI) were calculated. Data were downloaded once every 4 to 6 weeks for one year, from 14 January 2018 to 11 January 2019. Light data collected indicated that in none of the six locations did DLI reach recommended levels for either tomatoes or lettuce. Part of the reason is the tomato floor has glass on the roof and south side, but the east and west walls are solid, although painted white. This limits early morning sun and late afternoon sun in both sections. The carousels, being on the middle second floor, only get direct sun when plants are on the south vertical plane of each carousel. The rest of the circuit they do get some LED and HID supplemental light, but they are insufficient. Recommendations include increasing the number of LED bars at various locations within the carousels' circuits.

Specified Source(s) of Funding: Private Investors

3:15 PM – 3:30 PM

Conventional and Organic Fertilization Strategies for Baby Leaf Hydroponic Spinach (*Spinacia oleracea* L.) and Basil (*Ocimum basilicum* L.)

Neil Scott Mattson*; Meghan L. Powers and Masaki Kurosaki, Cornell University

Hydroponic producers are seeking information on effective organic fertilizers for leafy greens and herbs. Because organic fertilizers contain plant or animal by-products, nutrients must be mineralized into plant available form. Commercially available microbial inoculants or naturally prepared materials (e.g. vermicompost extract) may aid mineralization. The objective of this project was to determine the impact of one conventional and two organic fertilizers with and without microbial inoculants on nutrient solution elemental content and yield of baby leaf spinach (cv 'Carmel') and basil (cv 'Genovese') in deep water culture hydroponics. Styrofoam rafts containing 40-cells with soilless germination mix were sown with one seed in each 2.5x2.5 x4.4 cm (LxWxH) cell. Upon germination (cotyledon emergence), rafts were floated in 35-L hydroponic tubs. Crops were grown for three sequential cycles during which time the same nutrient solutions used, but with additions of fresh nutrient solution daily to make up for lost water. In each crop cycle, plants were harvested at 13 and 18 days after floating for spinach and basil, respectively. In experiment 1, spinach was grown with one of six treatments: Sonneveld's conventional fertilizer at 150 ppm N (control), control + non-aerated vermicompost extract at 10% by volume (NVE, Worm Power, LLC), Hydroser organic seaweed based fertilizer at the label rate (Qingdao Seawin Biotech Group Co., LTD.), and Hydroser + NVE. Plant fresh weight (FW) was greatest and not significantly different for control and control + NVE averaging 3.1 and 3.4 $g \cdot plant^{-1}$, respectively. For these two treatments FW did not vary by crop cycle. For Hydroser, FW was smaller than control and declined with crop cycle, and averaged 1.3 $g \cdot plant^{-1}$. For Hydroser + NVE, FW was smaller than control for cycles 1 and 2 (averaging 1.9 $g \cdot plant^{-1}$) and was similar to control for cycle 3 (3.2 $g \cdot plant^{-1}$). According to nutrient solution analysis, the NVE supplied some nitrate, plus NVE led to enhanced conversion of ammonium to nitrate by later crop cycles. In a second experiment, basil and spinach were grown with control, Hydroser, Pre-Empt organic fertilizer at label rate (Coastal Fertilizer & Supply, Inc.), and Pre-Empt + TerraBella commercial root microbial inoculant (AquaBella Organic Solutions, LLC). Basil was less responsive to fertilizer treatments, FW averaged 77, 87, and 97% of control for Hydroser, Pre-Empt, and Pre-Empt + TerraBella. For spinach, FW averaged 44, 45, and 46% of control for Hydroser, Pre-Empt, and Pre-Empt + TerraBella.

3:30 PM – 3:45 PM

Blue Radiation Interacts with Green Radiation to Influence Growth and Predominantly Controls Quality Attributes of Lettuce

Qingwu Meng*[1]; Jennifer Boldt[2]; Douglas Sturtz[2] and Erik S. Runkle[1], (1)Michigan State University, (2)USDA-ARS

Adding green (G; 500–600 nm) radiation to blue (B; 400–500 nm) and red (R; 600–700 nm) radiation creates white light to improve crop inspection at indoor farms. Although G radiation can drive photosynthesis and elicit shade-avoidance responses, its effects on plant growth and morphology have been inconsistent. We postulated G radiation would counter suppression of crop growth and promotion of secondary metabolism by B radiation, depending on the B photon flux density. We grew lettuce (*Lactuca sativa*) 'Rouxai' in a temperature-controlled growth room under nine sole-source light-emitting diode (LED) treatments with a 20-hour photoperiod or in a greenhouse. At the same total photon flux density (400–800 nm) of 180 $\mu mol \cdot m^{-2} \cdot s^{-1}$, we grew plants under warm-white LEDs or increasing B photon flux densities at 0, 20, 60, and 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ with or without substituting the remaining R radiation with 60 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of G radiation. Biomass and leaf expansion negatively correlated with the B photon flux density with or without G radiation. For example, increasing the B photon flux density decreased fresh and dry mass by up to 63% and 54%, respectively. The inclusion of G radiation did not affect shoot dry mass at 0 or 20 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of B radiation, but decreased it at 60 or 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of B radiation. Results suggest shade-avoidance responses are strongly elicited by low B radiation and repressed by high B radiation. Green radiation barely influenced morphology, foliage coloration, essential nutrients, or sensory attributes, regardless of the B photon flux density. Increasing the B photon flux density increased red foliage coloration and concentrations of several macronutrients (e.g., nitrogen and magnesium) and micronutrients (e.g., zinc and copper). Consumers preferred plants grown under sole-source lighting to those grown in the greenhouse, which were more bitter and less acceptable, flavorful, and sweet. We conclude lettuce phenotypes are primarily controlled by B radiation, and G radiation maintains or suppresses lettuce growth, depending on the B photon flux density.

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Postharvest 5

Moderator: Faisal Shahzad
Institute of Food and Agricultural Sciences, Lake Alfred, FL, USA

2:00 PM – 2:15 PM

Role of Mineral Nutrition in Citrus Fruit Quality and Postharvest Storage Life of HLB-Affected Mandarin Cv. 'LB8-9' (Sugar Belle®)

Faisal Shahzad*[1]; Jeffrey K. Brecht[2]; Yu Wang[2]; Fred Gmitter[2]; Mark A. Ritenour[2] and Tripti Vashisth[2], (1)Institute of Food and Agricultural Sciences, (2)University of Florida

Huanglongbing (HLB; citrus greening) is a serious endemic citrus disease caused by the bacterium *Candidatus* Liberibacter *asiaticus* (CLas). About 80-90% of citrus trees in Florida are estimated to be infected, resulting in >70%

decline in citrus production over the last decade. Fruit from HLB-affected trees are often of poor quality with non-uniform peel color, lopsided, and small size. In addition, symptomatic fruit have an off flavor and higher acidity, which makes them less desirable or unmarketable. A preliminary comparative study was conducted to evaluate the effect of preharvest foliar applied mineral nutrients (K, Ca, B, and combinations) on postharvest storage life and fruit quality of HLB-affected mandarin trees. Ten-year-old, 'LB8-9' trees grafted on Swingle rootstock, and exhibiting mild HLB symptoms were used in this study. Eight foliar applied nutrient treatments are as follow: control (grower standard), K, Ca, B, K+Ca, K+B, Ca+B and K+Ca+B. Treatments were applied at three time points (July, September and October) in 2018. Potassium nitrate, calcium nitrate and sodium borate were used as mineral nutrient sources for K, Ca and B respectively. Randomized complete block design with four replications was used and each replicate consisted of three trees. Following harvest, fruit were stored at 25 °C with 85% relative humidity for 21 days. With K+B treatment, fruit weight, diameter, peel color 'a' and 'hue' values were increased compared with the control. Fruit compression force and peel color 'b' value were higher with Ca treatment than other treatments. Sensory evaluation using the general labeled magnitude scale showed higher scores for mandarin flavor intensity and sweetness, and lower scores for sourness in K- and B-treated-fruit compared with the control fruit. Overall, K and B separately and in combination improved the fruit quality attributes of HLB-affected 'LB8-9'.

2:15 PM – 2:30 PM

Evaluation of Plant Growth Regulators on Cold Storage and Degreening of 'tango' and 'sugarbelle' Citrus Varieties

Daniel Adu Boakye* and Fernando Alferez, University of Florida

We evaluated the effect of several plant growth regulators on cold storage and degreening of the mandarin 'Tango' (Citrus reticulata Blanco) and the mandarin hybrid 'SugarBelle'['Clementine' mandarin (Citrus reticulata) x 'Minneola' tangelo (Citrus x Tangelo), 'Duncan' grapefruit (Citrus paradisi) x 'Dancy' tangerine (Citrus reticulata)] citrus varieties to assess their impact on peel coloration and internal quality after harvest. Fruit from both varieties were harvested at the color break stage and subjected to cold storage at 45 F (7.2 ºC), hormonal treatments and de-greening. Plant growth regulator (PGR) treatments were abscisic acid (ABA) 1 mM, gibberellic acid (GA3) 20 ppm, homobrassinolide (HBr) 1 µM, and water (control). Three replicates of 10 fruit per variety were used for each treatment and condition. Peel color was measured in PGR-treated cold-stored fruit at six days interval (day 0, 6 and 12). After 12 days, a subset of fruits from each PGR treatment was subjected to de-greening (84 o F and 95 % RH) with 5 ppm of ethylene or without ethylene (air). Peel maturation was measured every two days (day 0, end of 48 hrs of de-greening and 48 hrs after de-greening). We also measured total soluble solid content and titratable acidity to determine the SSC/TTA ratio. During cold storage, any of the PGRs assayed did not have significant effect on peel color advancement particularly when compared with water (control) for both varieties. Storage at 84 o F and 95 % RH in air advanced peel coloration in 'Sugarbelle' more than in 'Tango'. De-greening with ethylene significantly advanced peel coloration on ABA-treated fruits of 'Tango' as compared to the rest of PGRs after 48 hours of degreening, whereas in 'Sugarbelle' ethylene had similar effect on all PGR treatments. The SSC/TTA ratio was increased after storage at 84 o F and 95 % RH irrespective of ethylene or air treatment in both varieties as compared to cold storage except water and GA-treated fruit from 'SugarBelle'.

2:30 PM – 2:45 PM

Analysis of Genetic Differences Associated with Postharvest Storability of Strawberry Fruit Using Transcriptome Analysis

Kyeonglim Min* and Eun Jin Lee, Department of Plant Science, College of Agriculture and Life Sciences, Seoul National University

This study was conducted to investigate genetic factors associated with postharvest storability of five strawberry fruit cultivars (Seolhyang, Durihyang, Kingsberry, Sunnyberry, and Maehyang). Fruit were harvested for each cultivar according to fruit size and coloration (small-green, medium-green, large-pink, and large-red). Large-red fruit for each cultivar were stored at 10°C for 10 d to evaluate postharvest storability. Both firmness and decay were evaluated as major postharvest storability factors in our study. The firmness of Sunnyberry maintained longest for up to 10 d, but firmness of Kingsberry decreased most rapidly. The decay rate of Kingsberry was the highest (33%) and 6.6 times higher than that (5%) Sunnyberry. Our results showed that among five cultivars, the postharvest life of Sunnyberry and Kingsberry was the longest and shortest, respectively, so we used two cultivars for transcriptomic analysis to investigate the genetic factors associated with postharvest storability. Because changes in mRNA levels during fruit ripening and senescence could affect the postharvest storability of strawberry fruit, both green and red fruit stages for each cultivar were used for transcriptome analysis. In Kingsberry, expressions of cell wall degradation and secondary metabolism-related genes significantly increased during ripening, but not in Sunnyberry. Expressions of transporter genes highly upregulated in Sunnyberry compared to those in Kingsberry, especially in the red stage. Therefore, it is expected that the storability of Sunnyberry can be maintained longer during postharvest period by expressing cell wall degradation and secondary metabolism-related genes much less and by promoting the transport and accumulation of nutrients more actively than Kingsberry. This work was supported by the Rural Development Administration (RDA, PJ013648042019), Republic of Korea.

Specified Source(s) of Funding: This work was supported by the Rural Development Administration (RDA, PJ013648042019), Republic of Korea.

2:45 PM – 3:00 PM

Using [CO2]/ [O2] in Modified Air Packaging (MAP) System to Arrest *Botrytis Cinerea* Damage on Strawberries during Postharvest

Ariane Vasilatis*; Jeanne Peters; James Simon and Thomas Gianfagna, Rutgers University

Postharvest loss of horticultural produce continues to be a major area of study due to its impact on global food waste. Small fruit are particularly prone to such loss due to their limited shelf-life of mature fruit and their susceptibility to diseases during shipping and storage. Quality can be directly correlated with the age and maturity of the fruit and the rate of fruit respiration which has also been shown to stimulate pathogen activity. Increased levels of carbon dioxide and reduced levels of oxygen have been shown to slow the rate of respiration in fruit which could possibly cause a secondary effect on the pathogen signaling. In this study, *Botrytis cinerea*, a major postharvest pathogen, was evaluated for growth and maturation under 3 differential atmospheres: (1) a high CO2 and low O2 treatment, (2) high CO2, ambient O2, and (3) ambient CO2 and O2. Pure cultures were subjected to these parameters in Modified Atmosphere Packaging (MAP) bags and evaluated for both growth and the presence of sexual structures. Studies were conducted at room temperature as well as cold storage temperatures (0-4C) in order to simulate postharvest cold storage.

3:00 PM – 3:15 PM

Effect of Harvest Time on Red Drupelet Reversion in Blackberry (*Rubus* subgenus *Rubus*)

Mitchell E. Armour; Margaret Worthington* and John R. Clark, University of Arkansas

Red drupelet reversion is a disorder where drupelets on ripe blackberries (*Rubus* subgenus *Rubus*) revert from black to red color during or after postharvest storage. This condition can have a negative impact on consumer appeal as consumers generally prefer blackberries to have a uniform, black color with a glossy appearance. The incidence and severity of red drupelet reversion can be affected by cultural factors including mechanical damage, delayed postharvest cooling, heavy rainfall, and excessive nitrogen application. Blackberry genotypes also differ in their susceptibility to red drupelet reversion. Genotypes with firm fruit have been shown to experience lower rates of reversion than soft-fruited genotypes. A study was conducted in 2018 at the University of Arkansas Fruit Research Station in Clarksville, AR to test the effect of harvest time and fruit temperature on red drupelet reversion in seven cultivars and advanced breeding selections. The seven genotypes were chosen to represent a spectrum of fruit textures in the University of Arkansas blackberry breeding program. Two replicate clamshells were harvested from each genotype on two dates approximately one week apart at four different times of day (7 AM, 10 AM, 1 PM, and 4 PM) and surface temperature of the fruit was measured during harvest. Fruit was then held in cold storage at 4 ºC for seven days and returned to room temperature before measuring the percent of berries with three or more reverted drupelets per clamshell and performing compression to evaluate fruit texture. Analysis of variance was performed with the data analyzed as a split-plot design under a gamma distribution. Blackberries harvested at earlier times of day showed lower incidences of reversion, with the lowest percent reverted berries at 7 AM. Additionally, firmer genotypes, such as the ‘crispy’ selection A-2453, had lower percent reversion while softer genotypes, such as Black Magic™, had higher incidences of reversion.

3:15 PM – 3:30 PM

Optimization of Allyl Isothiocyanate Treatment to Reduce Mold (*Botrytis cinerea*) during Postharvest Blackberries Storage

Kang-Mo Ku*, Chonnam National University

In this study we conducted an experiment to optimization of allyl isothiocyanate (AITC) treatment concentration on postharvest quality of blackberries. Freshly harvested blackberry fruit were placed in plastic containers and treated with AITC at 0, 0.5, 1, 2 5 and 10 $\mu L\ L^{-1}$ for 12 h 4°C and stored 14 d at 4°C, RH 80%. The decay rate of all AITC treated blackberry groups after 14 d of storage at 4°C was lower than the control group. The application of 5 $\mu L\ L^{-1}$ or higher AITC concentration to blackberry fruits showed reduced total anthocyanin contents, surface color loss, total phenolic contents, and antioxidant activity. Three discriminant metabolites including sucrose, glucose, fructose, pentaric acid were found using an untargeted metabolomics approach among various AITC treatments. These sugars and TCA intermediate may be related to respiration rate. Also, stigamasterol and beta-sitosterol were significantly reduced in 5 and 10 $\mu L\ L^{-1}$ of AITC concentration. More investigation is still needed to elucidate the AITC treatment effect on blackberry fruit metabolite changes. Nevertheless, the results from this study indicated that 2 $\mu L\ L^{-1}$ AITC treatment was optimization concentration on blackberry for reduce gray mold and improve shelf-life.

3:30 PM – 3:45 PM

Ginger (*Zingiber officinale*) and Turmeric (*Curcuma longa*) Shelf Life and Quality Was Affected By Temperature and Packaging

Toktam Taghavi*; Monae Bell; Michelle Opoku; Carissa James; Rafat Siddiqui; Reza Rafie and Laban Kipkoriony Rutto, Virginia State University

Ginger (*Zingiber officinale*) and Turmeric (*Curcuma longa*) are grown as specialty crops in Virginia and are harvested before they reach to their full maturity. The immature “baby ginger and turmeric” tubers are perishable and prone to water loss and fungal diseases. Cold storage can decrease water loss and control fungal diseases. However, ginger and turmeric are tropical crops and we hypothesized that, immature tubers can suffer from chilling injury if stored at 4 ºC. Therefore, this experiment was designed to assess the effect of storage temperature on extending the shelf life of immature ginger and turmeric tubers in two consecutive years. Tubers were harvested from Virginia State University’s Randolph Farm between December and February. In the first year (Dec 2017- Feb18) tubers were stored either at 4 or 25 ºC and were packaged in plastic ziplock bags. In the second year (Dec 2018- Feb19), tubers were stored either at 4, 12 or 25 ºC and were packaged in grocery paper bags or clamshells. Tubers without visible defects were washed, gently dried, and then randomly divided between experimental treatments. Weight loss, total soluble solids (ºBrix) and titratable acidity were measured before storage and every 7 days for 28 days. The experiment was conducted in 3 replicates. In the first year, tubers stored at 4ºC had less water loss and fungal growth. Differences in total soluble solids and titratable acidity were not significant between the two temperatures. In the second year, discoloration occurred due to the chilling injury to tubers. Cold storage reduced water loss significantly and paper bags and clamshells reduce fungal decay compared to the plastic ziplock bags. Also, the pathogens present on the surface of the tubers have been isolated to identify the dominant fungal pathogens attacking the tubers and how postharvest practices can control them.

Specified Source(s) of Funding: Virginia State University CAREO Seed Grant

Viticulture and Small Fruits 4

Moderator: Edgar L. Vinson
Auburn University, Auburn University, AL, USA

2:00 PM – 2:15 PM

Bud Break Induction and Flower Abortion By Exogenous GA_3 in ‘Natchez’ Blackberry in Florida

Syuan-You Lin* and Shinsuke Agehara, University of Florida

Most commercial blackberry (*Rubus* subgenus *Rubus* Watson) cultivars require 300 to 900 hours of cumulative chill hours below 7.2°C to induce uniform flower bud break in spring. To achieve high blackberry yields under subtropical climates in Florida, strategies to improve bud break must be developed. Gibberellic acid (GA_3) is a phytohormone known to break dormancy and regulate flowering in many plant species. Our preliminary experiments demonstrated that a single application of GA_3 at 49 $g \cdot ha^{-1}$ was effective in inducing blackberry bud break, but its optimum application rate is unknown. A field experiment was conducted in west central FL in the 2017–2018 season to evaluate dose effects of exogenous GA_3 on phenology and yield of ‘Natchez’ blackberry. Plants were sprayed with GA_3 at four application rates (0, 25, 99 or 198 $g \cdot ha^{-1}$) at the end of the winter chill period (20 Feb. 2018). Cumulative chill hours below 7.2 °C during the 2017-2018 growing season were 230 hours. The onset of bud break, flowering, and fruit ripening was unaffected by exogenous GA_3. Although increasing GA_3 application rate increased the percentage of bud break from 25% to 58%, it decreased flower number by up to 81% (21.8 vs. 4.2 flowers per cane) as a result of flower abortion. Increasing GA_3 application rate also decreased the number and average size of marketable fruits by up to 62% (287 vs. 109 fruits/plant) and 36% (7.30 vs. 4.65 g/fruit), respectively. The consequent yield loss by GA_3 application was up to 83% (2.04 vs. 0.34 kg/plant). All measured responses were dose-dependent. These results suggest that exogenous GA_3 is effective in inducing blackberry bud break even under insufficient chilling conditions, but its practical use is not recommended for ‘Natchez’ blackberry because of the negative side effects on flower and fruit development.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant Program (FAIN#: USDA-AMS-SCBGP-2016)

2:15 PM – 2:30 PM

Caneberry Evaluations at Central and Southern Coast of California

Oleg Daugovish*[1]; Mark Gaskell[2]; Miguel Ahumada[3]; Anna Howell[2] and Gina Ferrari[2], (1)University of California Coop. Ext., Ventura, (2)University of California Cooperative Extension, (3)BerryWorld

Raspberry and blackberry are among most valuable crops in Coastal California, but evaluation of public varieties has been limited. Recent releases and selections from public breeding programs were tested in high tunnels at Santa Paula and Oceano, CA. We planted plugs of Kwanza, Kweli, Imara, PrimeArk (PA) 45 and PA Traveler in September 2016 and APF-268T, ORUS 4545-1, Vintage and Kokanee in April 2017. Each 8 by 3 ft plot had either four blackberry or six raspberry plants. During July-Dec of 2017 and May-Nov 2018 we harvested fruit at Santa Paula and from Jun to Dec at Oceano. At both locations, among raspberries planted in September 2016, Imara and Kweli were most productive during Jul-Oct 2017 harvest (with marketable yield 10-11 kg/plot) followed by Kwanza (6kg/plot). PrimeArk 45 blackberry yielded about 11 kg/plot followed by PA Traveler (~2 kg/plot). Fruit production during this period was <2 kg / plot for varieties planted in April 2017. Unmarketable fruit production followed the same trends, except for PA45 that had lesser fraction of unmarkable fruit than raspberries. On Oct 1, 2017 raspberries were either 1) cut back at 3 ft and defoliated leaving floricanes and allowing additional 25 primocanes per plot to develop, 2) same as 1 but floricanes removed 4 months later 3) mowed down to the ground and maintained at 25 primocanes per plot. Same management treatments were applied to blackberries in Jan 2018. In 2018 at Santa Paula all raspberries had similar yields (~4.5 kg/plot), greatly reduced by increased soil salinity and pH compared to 2017. However, blackberry yields in 2018 were greater than in 2017 and highest for PA45 (23kg/plot) followed by APF268T and ORUS4545-1 (10.5 kg and 7.8 kg/plot) and PA Traveler (6.5 kg/plot). All raspberries had greater yields in management treatment 1 compared to 2 and 3, while all blackberries yielded more under management 1 and 2 compared to 3 in 2018 at Santa Paula. Kwanza had largest fruit (5.5 g/berry) and Brix content among raspberries, and PA45 (8.3 g/berry) among blackberries. Blackberries had greater shelf life in cold storage than raspberries (among which Vintage was most susceptible to respiration related weight loss and decay).

Specified Source(s) of Funding: University of California Hansen REC

2:30 PM – 2:45 PM

Evaluation of Twelve Strawberry Cultivars for Their Production Potential in the Climate of Central Alabama

Edgar L. Vinson III*; Elina D. Coneva; J. Raymond Kessler; Matthew Price and Floyd M. Woods, Auburn University

Cultivar selection is one of the most important decisions strawberry farm operators make and it is the most practical means to solve production issues; however, there are few cultivars with documented adaptability from trial results to the climatic conditions of Alabama. Currently, ‘Camarosa’, has shown remarkable adaptability to the climatic conditions of Alabama and has replaced ‘Chandler’ as the market standard. To strength strawberry production in Alabama, a more diverse pool of cultivars is needed. The objective of this study was to evaluate several strawberry cultivars for their adaptability to Alabama growing conditions and their market potential to increase the number of suitable cultivars. A strawberry variety was established at the Chilton Research and Extension Center in Clanton, AL. Varieties included were ‘Albion’, ‘Chandler’, ‘Sweet Sensation’, ‘Ruby June’, ‘Camarosa’, ‘Festival’, ‘San Andreas’, , ‘Sweet Charlie’ ‘Flavorfest’, and ‘Camino Real’. Two advanced experimental lines, NCS 10-156 and NCS 10-083 but due to plant availability, only fruit size of these two selections were evaluated. Planting beds were established on October 5. Preplant herbicides were applied to each row on October 6 prior to the simultaneous installation of drip irrigation and black plastic mulch. Strawberry plug plants were transplanted on to experimental plots on October 20, 2017. Experimental plots were 20 ft long and spaced on 6 ft. centers. Plug plants were set planted in a double staggered configuration with 14 inches between plants within a staggered row and 14 inches between staggered rows resulting in a plant population of 12,342 plants per acre. The experiment followed a randomized complete block design. There were four replications per variety (treatment). Data collection consisted of early marketable yield (first seven harvests), early total yield (marketable yield plus cull weight), total marketable yield, total seasonal yield (total marketable yield plus cull weight), and berry size. An analysis of variance was performed on all responses using PROC GLIMMIX in SAS version 9.4 (SAS Institute, Cary, NC). Early marketable yield, early total yield, total market weight, total season yield, cull weight, and individual berry weight were analyzed using the normal probability distribution. Means were separated using the simulate methods. In early marketable yield and early total yield, there were no statistical differences among varieties. Berry size of ‘Flavorfest’ (20.3g) was similar to ‘Camarosa’ (22.3 g) but statistically larger than all other varieties. ‘Camarosa’ was similar to all other varieties in berry size.In total marketable yield, all varieties were similar to ‘Camarosa’ (11,859 lbs. /acre) with the exception of ‘San Andreas’ (494.4 lbs. /acre) and ‘Sweet Charlie’ (4,533 lbs. /acre). Additionally, total yield of ‘Camarosa’ (13,791 lbs. /acre) was similar to all other varieties but higher than “Sweet Charlie” (5,683 lbs. /acre) and ‘San Andrea’ (5,572.8 g). Fruit size of ‘Flavorfest’ (24 g) was similar to ‘Sweet Sensation’ (20.2 g), ‘Ruby June’ (19.9 g), ‘Albion’ (19.6 g) and ‘Camarosa’ (19.6 g). ‘Flavorfest’ performed as well as the market standard ‘Camarosa’ in all yield categories as well as in berry size.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant

2:45 PM – 3:00 PM

Increasing Honey Bee Stocking Density Improves Pollination in Two Blueberry Cultivars in Western Washington

Weixin Gan*, WSU and Lisa Wasko DeVetter, Washington State University Northwestern Washington Research and Extension Center

Highbush blueberry (*Vaccinium corymbosum*) is an economically important crop across North America and has become important worldwide. Washington State is one of the largest blueberry producers in the United States. Yield in western Washington is on average lower than eastern Washington and this may be partially due to poor pollination in the western part of the state. A previous study has shown that increased honey bee (*Apis mellifera*) hive density can promote pollination, subsequent berry mass, and estimated yields in ‘Duke’ grown in western Washington. While these results are promising, additional research on higher hive densities and more cultivars is warranted to confirm the results and identify the point of diminishing returns. The overall objective of this project is to evaluate the effects of modified honey bee hive densities on pollination, fruit set, estimated yield, and fruit quality attributes in blueberry grown in western Washington. Three different hive densities [10 (control; standard grower practice), 20, and 25 hives/ha] were introduced to ‘Draper’ and ‘Duke’ blueberry fields at 5% bloom. Honey bee visitation, fruit set, average berry mass, seed number, firmness, °Brix, and estimated yield/ bush were measured in 2018. Results showed that both 20 and 25 hives/ha increased both honey bee visitation and fruit set, and 25 hives/ha had the highest honey bee visitation and fruit set in ‘Draper’ and ‘Duke’ blueberry compared to the control treatment of 10 hives/ha. An important trend was observed whereby the higher hive density sites tended to have greater yields. Although yield was not significantly different by treatment, this numerical difference in yield may be economically important for growers. This work is ongoing and will be repeated in 2019, but results continue to demonstrate increasing honey bee hive densities is a promising strategy to improve production in pollination-limited western Washington.

Specified Source(s) of Funding: Washington Blueberry Commission

3:00 PM – 3:15 PM

Effects of Hydroshield, a Novel Plant Cuticle Supplement, in Conjunction with Reduced Irrigation Water on ‘Cabernet Sauvignon’ Grapes in Eastern Oregon.

Clive Kaiser*[1]; Vaughn Walton[1] and James Harbertson[2], (1) Oregon State University, (2)Washington State University

A novel plant cuticle supplement, HydroShield, was formulated in Milton-Freeewater and refined by the authors through multiple laboratory tests. A field prototype was applied four times at 0.5% in 60 gal per acre to ‘Cabernet Sauvignon’ Clone 8. Vines were irrigated with drippers delivering either 0.75 gal per hour (25% reduction in irrigation water) or 0.5 gal per hour (50% reduction in irrigation water) and compared against an untreated check which received 1.0 gal per hour (0% reduction). Vines were grown under deficit irrigation and multiple techniques were adopted to ensure vigor was contained, including pressure bomb, soil moisture monitoring using gypsum block as well as monitoring tendril development. In addition, soil moisture was monitored at 4 depths (100, 200, 300 and 400 mm) on a weekly basis using a Delta T HH2 device. In 2017, soil moisture at all depths was comparable between treatments however, at the 400 mm depth of vines grown under 50% reduction irrigation water began to dry out at the end of the growing season compared to . Veraison was accelerated by 7 days in the 25% reduction but reduced by 3 days for the 50% reduction compared to the untreated check. Yields, berry size, TSS, acidity, flavonoid and phenolic panels for all the grapes were not significantly different between treatments or the check. In 2018, soil moisture across the season was similar to the previous year however, there was more soil moisture in the 25% reduction in conjunction with HydroShield when compared to the 0% reduction which suggests water savings. Shoot length and number were measured for all treatments to determine whether less growth accounts for the less water usage. Yields of the 25% reduction in irrigation water were again not significantly different from the untreated check however the 5o% reduction in irrigation water resulted in significantly lower yields the the 25% or 0% reduction treatments. Version was again accelerated by the 25% reduction but retarded by the 50% reduction. Fruit quality parameters as before were not significantly different when comparing all treatments agains the untreated check. Differences in phenolic and flavonoid panels will be reported on.

Specified Source(s) of Funding: Oregon Department of Agriculture Specialty Crop Block Grant

3:15 PM – 3:30 PM

δ^{13}c of Grape Must Is a Reliable Predictor of Water Stress in Precision Viticulture

Kaan Kurtural*, University of California and Runze Yu, University of California Davis

Vineyard ecophysical variations limit vineyard efficiency in production and berry chemistry. A mechanically managed Cabernet Sauvignon (*Vitis vinifera* L.) vineyard was modeled to investigate the ecophysiological variability in Napa County, California, including soil electric conductivity (EC), plant water status, carbon isotopic discrimination analysis ($\delta^{13}C$), and berry primary and secondary metabolites. Plant water status can be used to delineate vineyard to homogenize grapevine physiological traits at harvest and $\delta^{13}C$ is used as an alternative approach to assess plant water status without being time-sensitive as the traditional measurement in precision viticulture. An equidistant grid sampling was performed and stem water potential (Ψ_{stem}), leaf gas exchange were measured weekly during the growing season, and their integrals were calculated. $\delta^{13}C$ was measured at harvest, it was directly related to Ψ_{stem} (R^2 = 0.69), stomatal conductance (R^2 = 0.27), carbon net assimilation (R^2 = 0.25), water use efficiency (R^2 = 0.67). Soil electric conductivity measurement only showed a relationship with plant water status at the depth of 1.5m (deep EC, R^2 = 0.23).The vineyard was then deliniated by k-means clustering of Ψ_{stem} into two zones: Zone 1 with higher water stress, and Zone 2 with lower water stress. There was no difference between the two zones in total soluble solids, titratable acidity, and pH. Berry skin and weight were greater in Zone 2, but yield and cluster number per vine were the same between two zones. Zone 2 had higher peonidin-, malvidin-3-glucoside contents per berry, but lower tri- to di-hydroxylated anthocyanin ratio. There were no differences in berry skin flavonol content. Our results provided evidence that delineating vineyard by plant water status with $\delta^{13}C$ can be a reliable assessor of vineyard water stress, as well as in assessing ecophysical variability in mechanically managed vineyards without traditional labor input in a precision viticulture approach.

3:30 PM – 3:45 PM

Water Movement Mechanisms in Grapevines during Hydraulic Redistribution: Counting on

the Phloem

Nataliya Shcherbatyuk* and Markus Keller, WSU, Prosser-IAREC

Plants redistribute water between root sections and soil layers along a gradient of decreasing water availability. Therefore, water can be transported from roots in wet soil to roots in dry soil, delaying the onset of water stress and increasing root longevity in dry environments. Grapevines are thought to redistribute water laterally across the trunk from wet to dry portions of the root system. However, it is unknown whether the phloem contributes to such water redistribution. The hypothesis of this study was that hydraulic redistribution in grapevines is in part due to water movement from wet roots to the leaves via the xylem and recycling from the leaves to dry roots via the phloem This study used deuterium-labeled water (^2H_2O) as a tracer of water movement. Own-rooted *Vitis vinifera* L. cv. Merlot grapevines were grown in three-way split root pots. One of the three compartments was irrigated with ^2H_2O and the other two were left to dry. The trunk in one of the dry compartments was girdled and the other one was left intact to distinguish between xylem and phloem water movement. Xylem sap and phloem sap, trunk and root tissue, and soil samples were collected. Water was extracted via a cryogenic method and analyzed for deuterium enrichment (δ^2H). Following ^2H_2O supply to the roots, strong ^2H enrichment was found in both xylem and phloem sap collected from petioles. Moreover, the δ^2H values were significantly higher in root and soil samples collected from the dry/intact compartment than in samples from the dry/girdled compartment. These results indicate water moves from roots in wet soil to leaves via the xylem and recycles from leaves to roots in dry soil via the phloem. This xylem-to-phloem redistribution in drought-stressed grapevines keeps roots in dry soil alive, as long as a portion of the root system has access to soil water.

Specified Source(s) of Funding: Chateau Ste. Michelle Distinguished Professorship; WA State Grape and Wine Research Program; WSU Graduate School

3:45 PM – 4:00 PM

Cordon Renewal Strategies for Reviving Cold-Injured Merlot Grapevines

Hemant Gohil*, Cooperative Extension of Rutgers University; Lynn Mills, Washington State Uni. and Markus Keller, WSU, Prosser-IAREC

Recurring winter freeze events over the years can result in gradual vine decline and reduced yields, prompting growers to consider vine renewal or replanting strategies. Unlike vineyard replanting, successful cordon renewal may result in a full crop within 1 to 2 years. This study evaluated the potential of four different cordon renewal strategies to revive an aging and declining, cordon-trained Merlot (*Vitis vinifera*) vineyard in southeastern WA. Cordon renewal treatments, applied in March 2014, were: 1) standard spur pruning (control) – existing spur positions were pruned to 2-bud spurs; 2) short canes – three sequential, non-overlapping canes pruned to 5 to 8 buds each were trained onto the cordon while the remainder of the cordon was disbudded; 3) complete disbudding – all visible buds were removed from the cordon; 4) cordon removal – the trunk was cut ~13 cm below the cordon wire, and one strong sucker was retained the following winter and trained onto the wire to reestablish the cordon. Vegetative growth, yield and pruning components as well as fruit quality was measured for three years. None of the cordon renewal strategies tested succeeded in restoring adequate vigor in these vines. However, retaining three short canes (5 to 8 buds each) per cordon increased 3-year average and cumulative yields compared with cordon removal, disbudding, and standard spur pruning. Cordon removal and retraining led to more uniform recovery than other treatments. Complete disbudding of the cordon to encourage renewal of spur positions resulted in yields that were no better than those obtained with continued standard spur pruning. Fruit composition was similar in all four pruning treatments, and the slight differences that were occasionally observed were within the expected range of technological maturity for high quality fruit.

Specified Source(s) of Funding: Washington State Wine Advisory Council

Part 3: Poster Presentations

POSTER PRESENTATIONS

Tuesday, July 23, 2019

Fruit Breeding 1 (Poster)

Fox Hunting in Wild Apple:a Resource for Functional Studies of Apple Genes *(Poster Board #239)*

Michael Wisniewski*[1]; John Norelli[1]; Erik Burchard[1]; Timothy Artlip[2] and Jing Ma[1], (1)USDA-ARS, (2)USDA-ARS, AFRS

M. sieversii represents a source of genetic diversity for economically-important apple traits, including stress and disease resistance, as well as unique fruit quality attributes. USDA-sponsored expeditions to Central Asia have resulted in a large collection of *M. sieversii* accessions that are maintained at the USDA Plant Genetics Resources Unit (PGRU) in Geneva, NY. *M. sieversii* - PI 613981, is one of the elite lines that was originally selected for collection in Kazakhstan as budwood for its potential drought tolerance and disease resistance. The identification of genes responsible for these and other traits, in *M. sieversii*, however, have not been explored. The characterization of functional genes in wild apple and the establishment of independent overexpressing lines in *Arabidopsis* that could be used for high-throughput screening would represent a valuable resource for studying apple traits. Thus far, large-scale, high-throughput screening for stress tolerance genes in apple has not been conducted. In the present project, the FOX (Full-length cDNA Over-eXpressing) gene hunting system, which represents an alternative gain-of-function gene hunting technique, has been used to generate 10 - 12,000 gain-of-function mutant lines in *Arabidopsis* carrying independent apple cDNAs derived from a cDNA library of *M. sieversii* – PI613981 constructed from mid-winter bark tissues. The high-throughput screening effort will focus on identifying genes related to freezing tolerance, salt tolerance, drought tolerance, and morphological traits (dwarfing, early-flowering, branching, root architecture, etc.). Initial characterization of the system, a sampling of inserted apple genes, and examples of morphological mutants will be presented.

Genome Wide Association Studies for Postharvest Traits in Peach (*Prunus persica* (L.) Batsch) *(Poster Board #240)*

Cassia Da Silva Linge*[1]; Wanfang Fu[1]; Ksenija Gasic[1]; Jennifer Lewter[2]; Margaret Worthington[2]; Zena Rawandoozi[3]; David H. Byrne[3] and Carlos H Crisosto[4], (1)Clemson University, (2)University of Arkansas, (3)Texas A&M University, (4)University of California - Davis

Peach is the third most important temperate tree fruit in the world after apple and pear. According to FAOSTAT, world peach production in 2017 reached over 24.6 million tons, with the U.S. being the fifth producer in the world with approximately 775,189 tons. However, peach consumption per capita has decreased over the last decade, most likely due to inconsistent quality of the fruit on the market. Many peaches have excellent quality picked fresh from the tree (at harvest), but after being held in cold storage, the peaches can develop storage disorders and/or chilling injury (CI) symptoms such as mealy texture, brown flesh, loss of flavor, and development of 'off flavors'. Therefore, maintenance of fruit quality after cold storage is a high priority. Susceptibility to postharvest disorders is highly influenced by genetic background. Fortunately, peach germplasm that is less susceptible to CI exists and can be used in new cultivar development. To understand the genetic background of CI development during cold storage we performed a genome wide association study (GWAS) using GModel on a total of 426 individuals from three public fresh market peach breeding programs (University of Arkansas, Texas A &M University, and Clemson University). The material was genotyped with the new Illumina 9+9K SNP peach array and phenotyped for: Bleeding (BL), Expressible Juice (EJ), Browning (BRO), Texture (TEX) and Mealiness (ME) in two seasons (2015 and 2016). GWAS revealed 122 markers in all chromosomes associated with these postharvest traits. TEX and ME were positively correlated and associated with markers on linkage groups (LGs) 1, 3, 5, 6 and 7. A SNP marker associated with all measured post-harvest traits was detected on LG4, and one associated with four of the traits (EJ, BRO, TEX and ME) was detected on LG6. Candidate gene analysis within the haploblock regions encompassing the associated markers on LG4 and 6 identified 14 and 15 predicted genes, respectively. Functional annotation of these 29 predicted genes classified them within the following GO terms: metabolic process, antiporter activity, hydrolase activity, catalytic activity and cell wall modification. The genetic mechanisms that control CI in peach and their implication on breeding for CI resistant peaches will be discussed.

Identification of QTLs for Blush, Soluble Solids Content, and Titratable Acidity Traits in Peach *(Poster Board #241)*

Zena Rawandoozi*[1]; Timothy P. Hartmann[1]; Ksenija Gasic[2]; Cassia Da Silva Linge[2]; Lichun Cai[3]; Nahla Bassil[4]; Eric van de Weg[5] and David H. Byrne[1], (1)Texas A&M University, (2)Clemson University, (3)Michigan State University, (4)

USDA-ARS NCGR, (5)Wageningen University & Research
Fruit quality traits have a significant effect on consumer acceptance and subsequently on peach (*Prunus persica* L. Batsch) consumption. Pedigree-based analysis (PBA) using Visual FlexQTL software has been conducted on seven low to medium chill F_1 families along with the founders and parents. Phenotypic data were collected over two years at a high chill (Fowler, CA) and medium chill (College Station, TX) locations and genotyped using the 9K SNP Illumina array. The objectives of this study were to 1) identify QTL(s) associated with fruit quality traits; 2) estimate QTL genotypes for important breeding parents; 3) identify predictive single-nucleotide polymorphism (SNP) or haplotype alleles for desired QTL alleles; and 4) determine source of the alleles for three important fruit quality traits, namly blush (BL), soluble solids content (SSC), and titratable acidity (TA) through pedigree-based analysis (PBA) on Texas peach/nectarine germplasm. Our analysis detected one major QTL on the central part of LG4 for blush at interval 42 – 44 cM that explained about 20 % of the total phenotypic variance (PVE). A major QTL for TA co-localized with the major locus for low-acid fruit (*D*-locus) at the proximal end of LG5 at 0 - 0 cM. This QTL was consistent across all data sets, explaining about 60 % of the phenotypic variance. There was a QTL at the distal end of LG5 at 52 - 62 cM that was associated with both TA and SSC, which explained about 15 % of the phenotypic variance. In addition, haplotype analyses for these QTLs revealed unique SNP haplotypes that are associated with the predictive SNP marker(s) of desired QTL alleles along with their original sources. Our findings will help peach breeders develop new predictive DNA-based molecular marker tests that can be used routinely in marker-assisted breeding (MAB) for enhancing peach quality traits.

Specified Source(s) of Funding: RosBREED

Development and Evaluation of a 9K SNP Addition to the Peach Ipsc 9K SNP Array v1 *(Poster Board #242)*

Ksenija Gasic[*1]; Cassia Da Silva Linge[1]; Luca Bianco[2]; Michela Troggio[2]; Laura Rossini[3]; Daniele Bassi[4]; Maria Jose Aranzana[5]; Pere Arus[6]; Ignazio Verde[7]; Cameron Peace[8] and Amy F. Iezzoni[9], (1)Clemson University, (2)Fondazione Edmund Mach di San Michele all'Adige, (3)Università degli Studi di Milano, (4)Universita degli Studi de Milano, (5)IRTA, (6)Inst De Recerca I Tecn Agro, (7)CREA, (8) Washington State University, (9)Michigan State University
The IPSC 9K peach SNP array released by the international community has been a valuable tool in research and application. Even though majority of SNPs (84%) were polymorphic in the evaluation panels there were many genomic regions with low coverage, including those important for breeding. The existing peach array has been updated with 9K additional SNPs covering previously identified gaps and including recently identified SNPs important for breeding. SNPs (1,808,996) identified by sequencing 49 genomes of additional peach accessions were used as the main source of additional SNPs. Focal point strategy was used to select 8,971 SNPs within 40kb window from the 2,821 focal points distributed across the genome. Additional 129 SNPs were chosen to saturate either regions important for breeding or close the gaps larger than 100kb. The array was validated with 1,770 peach and 26 Prunus accessions (almond, plum, apricot, wild relatives). The add-on contained 7,862 SNPs evenly spread across 8 peach pseudo-molecules with only one SNP positioned on scaffold 13 covering 224.99Mbp of peach genome. The 9K add-on improved the 9K peach array by increasing the total number of usable SNPs by 7,206. The number of SNPs per chromosome increased on average by 50% with only on average 0.18% increase in total physical coverage. Number of gaps larger than 0.3 Mbp was reduced to 2 one on each chromosome 3 and 8. Overall genotyping efficiency in all material was >90% except in almond, 82%. Number of informative markers, assessed by ASSIsT software, were highest in peach 64% and lowest in almond 10%, with 61% of markers being informative in wild Prunus (12) and 35% in apricot (4) and 2 - 33% in Japanese and European plum, respectively. Among 36.2% discarded markers 33% were monomorphic and 30% shifted homozygous in material used. Those markers could be informative in different background raising total number of informative markers. Ann addition of new SNPs to array improved the density and usefulness of the array in Prunus species. The practical applications of new 16K Illumina SNP peach array will be discussed.

Specified Source(s) of Funding: USDA-NIFA-SCRI-RosBREED (2014-51181-22378)

Genome Wide Association Studies for Fruit and Leaf Resistance to Bacterial Spot [*Xanthomonas Arboricola* pv *Pruni* (*Xap*)] in Peach *(Poster Board #243)*

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Bacterial spot, caused by the bacterium *Xanthomonas arboricola* pv. *pruni* (*Xap*), causes premature defoliation, reduced vigor and productivity, and yield loss due to unmarketable fruit in peaches (*Prunus persica* (L.) Batsch) grown in humid regions around the world. The development of bacterial spot resistant peach cultivars could help to mitigate the environmental and health risks of bactericides applied for disease control while reducing input costs for growers. Because *Xap* pressure varies from year to year depending on environmental conditions and disease incidence is low in some important breeding sites, molecular markers associated with bacterial spot resistance can help breeders to develop resistant cultivars efficiently. Markers for fruit resistance to bacterial spot developed from quantitative trait

loci (QTL) discovered on linkage groups (LG) 1 and 6 and in an 'O'Henry' x 'Clayton' F_2 mapping population are currently used in the University of Arkansas System Division of Agriculture (UA) and Clemson University peach breeding programs as part of the RosBREED project. A genome wide association study (GWAS) was conducted over five years to find additional loci contributing to fruit and leaf *Xap* resistance in UA peach breeding germplasm. Seven breeding populations and their parents (n = 144) were genotyped with the 9K peach array and phenotyped for fruit and leaf *Xap* symptom severity at the UA Fruit Research Station (FRS) in Clarksville, AR from 2013-2015. One of the same populations (n = 47) and six new populations (n = 78), were genotyped with the 9+9K SNP array and evaluated for fruit and foliar resistance to natural inoculum in the field at FRS 2017 and 2018 and foliar resistance with detached leaf assays using two *Xap* isolates from North Carolina and Arkansas. GWAS was performed using a MLM model in Tassel and a Q+K model in FarmCPU. Foliar resistance was quantitatively inherited and controlled by several small-effect QTLs located on chromosomes 2, 3, 4, 7, and 8. Fruit resistance was also quantitatively inherited and controlled by multiple small-effect QTLs located on chromosomes 2, 3, and 6.

Specified Source(s) of Funding: RosBREED 2: Combining disease resistance with horticultural quality in new rosaceous cultivars (2014-51181-22378)

Genome-Wide Association Study for Tensile Strength between Berry and Stem in Grapevine. *(Poster Board #244)*

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Berry drop of grapes is a ubiquitous phenomenon during storage and transportation. If the berry falls off the stem, the value as a product drops and the juice leaking from the falling part causes additional infection and increases the disposal rate. In the experiment, the Fruit detachment force(FDF) between stem and berry was measured using a TA-PLUS texture analyzer (Lloyd Instrument, U.S.A.). To go beyond GWAS(Genome Wide Association statistics), we exploit the panel of 263 cultivars crossed with Tano Red X Ruby seedless and other 14 cultivars collected from the vineyard of National Institute of Horticultural and Herbal Science(NIHHS) in Wanju. 5~10 berries with stem from each cultivar were measured. The texture analyzer was programmed to measure the force required to pull apart berry and stem. The force relates to upward movement which is perpendicular to the longitudinal axis of the stem-berry system. The mean value of the force was 1.0 to 16.6N. The set of grape cultivars underwent genotyping by sequencing (GBS), yielding 25,465 polymorphic and informative single-nucleotide polymorphisms (SNPs) after data editing. Using GBS data, cultivar phenotypes were converted into formatted data for GWAS analysis using TASSEL, GAPIT software. By TASSEL, 64 of significantly associated markers were identified from 25,465 SNPs. The P-values of the detected associations ranged from 8.12×10^{-8} to 8.29×10^{-16}. Of these markers, the most significant associations were present on chromosome 18, which contained 56 significantly associated markers. Our findings will help future studies of the genetic analysis on the berry traits in grape.

Specified Source(s) of Funding: The Next-Generation BioGreen 21 Program

'Rubycrisp', a New Home-Garden Muscadine Grape with Hermaphroditic Flowers and Large Red Berries. *(Poster Board #245)*

Patrick J Conner*, University of Georgia

'RubyCrisp' is an hermaphroditic muscadine grape (*Vitis rotundifolia* Michx.) with red berries that was released by the University of Georgia (UGA) College of Agriculture and Environmental Sciences. 'RubyCrisp' produces high yields of large-sized berries with excellent taste suitable for the home-garden and you-pick markets. 'RubyCrisp' is novel in that it produces dark red berries rather than the normal black or bronze berry colors that typify muscadine. 'RubyCrisp' berries are also distinct in that they have firm flesh and a crisp, palatable skin and relatively low muscadine aroma. Yields of 'RubyCrisp' were equal to or better than other hermaphroditic cultivars tested. Berry weight is approximately 15 g, similar to 'Supreme' and 'Paulk'. Ripening time is in the middle season, with the first picking occurring on Aug. 21 in Tifton, Ga., similar to 'Supreme' and 'Fry'. RubyCrisp berries averaged 15.9 brix at harvest, compared to 14.0 brix for 'Supreme' and 15.3 brix for 'Paulk', this was higher than all other test cultivars except 'Lane'. 'RubyCrisp' is likely unacceptable for the commercial market because the thin, crisp skin results in unacceptable berry split.

Mission Melon: Improving Qualitative Traits in *Cucumis Melo* Using Phenomics *(Poster Board #246)*

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Cucumis melo var. reticulatus (muskmelon) is a diploid, andromonoecious species in the Cucurbitaceae family with origins in India. Muskmelon has had robust cultivation growth over the last century due to its' culinary appeal and health benefits. The United States ranks fifth internationally for production with a three-hundred-million-dollar market, following countries such as China, Turkey, and Spain. Among the states that produce melons, California grows over 60 percent (1 million tons/year) of the total U.S. market from June to October. In the off-season from November to May, melons are imported from Costa Rica, Guatemala, and Mexico. A decline in production can be attributed to the increase in the cost of production and the lack of adapted cultivars. The objective of this study is to address the producer and consumer needs' in a dynamic market by developing and identifying hybrid cultivars adapted to the Texas growing environment, with enhanced fruit quality and improved yield potential through breeding elite inbred lines. Andromonoecious breeding lines were used as six maternal parents and six paternal parents in a North Carolina II factorial design to produce thirty-six F1 hybrids. Field evaluations were conducted in Uvalde, Texas during the Spring of 2019 to determine a range of qualitative traits, high-parent heterosis, broad-sense heritability, and the general combining ability of the F1 hybrids within the population. Evaluation parameters for the traits of interest include netting height, width, and coverage; weight (lbs.), shape and size (cm.); colorimeter values (CIE **L, *a, *b*); penetrometer (N); Brix (TSS %); abscission size; cavity fill percentage and physiological defects present. A similar population evaluated in 2018 had a range of qualitative traits: weight (lbs.), firmness (N), and percent total soluble solids (TSS %), from 1.8 – 14.3 lbs., 11 – 134 N, and 4.8 – 15.6 % TSS under a control (normal irrigation) and treatment one (water deficit). Measured heritability estimates for were relatively low: a*, 0.4584; b*, 0.2506; weight, 0.2513; size, 0.2204; flesh color, 0.2454. Under the control treatment, high-parent heterosis for TSS % ranged from -35.78 to 16.83; drought treatment TSS % ranged from -16.16 to 18.67. An analysis determined a biological explanation for the positive correlation in qualitative traits, as well as identified a useful hybrid (BL 110 x BL 109). This study was supported by the United States Department of Agriculture-NIFA-SCRI- 2017-51181-26834 through the National Center of Excellence for Melon at the Vegetable and Fruit Improvement Center of Texas A&M University.

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The Kentucky State University Pawpaw Breeding Project *(Poster Board #247)*

Kirk William Pomper*; Sheri B. Crabtree and Jeremiah Lowe, Kentucky State University

The North American pawpaw [*Asimina triloba* (L.) Dunal] is a native tree-fruit that is in the early stages of commercial production across the southeastern United States with fresh market appeal for farmers markets, community supported agriculture, and organic markets, as well as processing potential for frozen pulp production. Although there are approximately 50 pawpaw cultivars available, many pawpaw varieties tend to be low yielding and have small fruit size of less than 120 grams. Pawpaw varieties with fruit weighing over 120 g per fruit are considered to have a large enough fruit size for commercial sale and processing. New high yielding cultivars with excellent fruit quality would further assist in the development of the pawpaw industry. Kentucky State University has already released three pawpaw cultivars, KSU-Atwood™ in 2009, KSU-Benson™ in 2016, and KSU-Chappell™ in 2018. However, additional high quality cultivars are needed. In 2013 and 2014, crosses were made between 'Sunflower' x 'Susquehanna', 'Susquehanna' x 'Sunflower', Hi4-1 x 'Sunflower' 'Sunflower' x 7-90, and open pollinated seedlings of 'Shenandoah' and 'Susquehanna'. Seeds were extracted from fruit produced from the crosses and seed was sown in soilless medium in the greenhouse. In 2017, all seedlings were then field planted, with 32 seedlings of 'Sunflower' x 'Susquehanna', 35 seedlings of 'Susquehanna' x 'Sunflower', 37 seedlings of Hi4-1 x 'Sunflower', 19 seedlings of 'Sunflower' x 7-90, 60 open pollinated seedlings of 'Susquehanna', and 14 open pollinated seedlings of Shenandoah. To evaluate establishment of the genotypes, survival of trees in the planting was evaluated in 2018. The survival rate was: 34% for seedlings of 'Sunflower' x 'Susquehanna', 31% for seedlings of 'Susquehanna' x 'Sunflower', 38% for seedlings of Hi4-1 x 'Sunflower', 73% seedlings of 'Sunflower' x 7-90, 53% for open pollinated seedlings of 'Susquehanna', and 71% for open pollinated seedlings of 'Shenandoah'. For the 197 seedlings planted, the overall survival rate for the planting was 47%. Many trees that had died will be replaced with the same type seedling in 2019. For all selections, the time to bloom, fruit weight, yield, and disease susceptibility will be evaluated in the coming years.

Specified Source(s) of Funding: USDA NIFA Evans Allen Research

KSU-Chappell™: A Unique Pawpaw Selection from Kentucky State University *(Poster Board #248)*

Kirk William Pomper*; Sheri B. Crabtree and Jeremiah Lowe, Kentucky State University

The North American pawpaw [*Asimina triloba* (L.) Dunal] is a native tree-fruit that is in the early stages of commercial production. Pawpaw fruit have fresh market appeal for farmers markets, community supported agriculture, and organic markets, as well as processing potential for frozen pulp production. In 2018, the Kentucky State University Land Grant Program released the pawpaw cultivar, KSU-Chappell™. This cultivar is the third pawpaw cultivar released by the university and follows KSU-Atwood™ released in 2009 and KSU-Benson™ which was released in 2016. The KSU-Chappell™ pawpaw is a mid-season ripening cultivar that is extremely vigorous and high-yielding. KSU-Chappell™ bears large fruit with a creamy, sweet, mild banana-pineapple flavor with floral notes, and low percent seed. The average fruit weight is even larger on average then currently available large fruited pawpaw cultivars. From 2016, 2017, and 2018, the average fruit size for KSU-Chappell™ was 214 grams, compared to Susquehanna, a large fruited commercially available variety, at 180 grams. Additionally, from 2016, 2017, and 2018, the percent seed in fruit for KSU-Chappell™ was 5.9 % seed, compared to Susquehanna, a low seed commercially available variety, at 5.8%. Therefore, KSU-Chappell™ can be classified as a large fruited and low seed cultivar for production. This cultivar is easy to propagate clonally via a number of budding (e.g., chip budding) and grafting techniques (e.g. whip and tongue, bark inlay, etc.) on pawpaw seedling rootstock that is actively growing. Trees of KSU-Chappell™ are available for purchase from licensed nurseries. A list is available at kysu.edu/pawpaw.

Specified Source(s) of Funding: USDA NIFA Evans Allen Research

Growth Chambers and Controlled Environments 1 (Poster)

Light Spectrum Affects the Response of Greenhouse Tomatoes to Long Photoperiod of Supplemental Lighting *(Poster Board #161)*

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Supplemental lighting is essential for year-round greenhouse crop production in regions with low natural light conditions. The supplemental lighting for increasing daily light integral can be added via lengthening photoperiods or increasing light intensity or both. Light addition via long photoperiods is more economical because less light fixtures are required, assuming the long photoperiods do not affect the response of plants to lighting. However, photoperiods longer than 17 or 18 hours cause photo-injury such as leaf chlorosis in greenhouse tomatoes, cucumbers and sweet peppers, limiting the yield increase at long photoperiods of lighting. In our previous study, we found that light spectrum affected the response of greenhouse cucumbers to long photoperiods of lighting. This study was conducted to investigate the influence of light spectrum on the response of greenhouse tomatoes to long photoperiods of LED lighting. The study was conducted in a large greenhouse (200 m^2) during winter 2018-19. The greenhouse was divided into 8 sections with white curtain and 4 combinations of LED lighting treatments (2 top light spectral compositions and 2 photoperiods) were applied in the 8 sections. The 2 light spectral compositions were 100% red or mixed light (red:blue:white =76:16:8). The supplemental light was provided at 150µmol m^{-2} s^{-1} for 17 hours (23:00 to 16:00) or 111µmol m^{-2} s^{-1} for 23 hours (17:00 to 16:00) at the same daily supplemental light integral (9.2mol m^{-2} d^{-1}). Because it was still daytime between 16:00 to 17:00. The actual photoperiod was 18 hours and 24 hours (continuous light) for the 2 photoperiod treatments, respectively. The 24-hours photoperiod resulted in severe leaf chlorosis and yield decrease in comparison to the 18-hours photoperiod. There was significant interaction between photoperiods and light spectral compositions. The leaf chlorosis and yield decrease at 100% red light was significantly less than at the mixed light compositions, which clearly demonstrated that response of tomatoes to long photoperiod (continuous light) was affected by light spectral compositions.

Optimum Light Intensity and Photoperiod for Growth and Phytochemical Accumulation of Koreans Mint (*Agastache rugosa*) Grown in an Indoor Farming System *(Poster Board #162)*

Jongseok Park* and Sungjin Kim, Chungnam National University

The aim of this study was to investigate optimum light conditions for increasing growth and phytochemicals contents of Korean mint (*Agastache rugosa*) grown under a hydroponics culture system in a controlled environment room. First, 100, 200, and 400 µmol·m^{-2}·s^{-1} were tested with florescence lamps for finding suitable photosynthetic photon flux density (PPFD) for 3 weeks experiment period (EX-1). Several photoperiods of 12/12, 16/8h, 20/4h, 24/0 hours (day and night) were investigated for growing and accumulation of rosmarinic acid and tilianin of Korean mint (EX-2). Finally, combination of PPFD-photoperiod, 133-24, 160-20, 200-16, 266-12, and 400-8 hours, under the same daily light integral (DLI), with florescence lamps were treated for how affected the growth and accumulation of rosmarinic acid and tilianin in an environment-controlled room for 4 weeks (EX-3). The air temperature and relative humidity of the room was maintained at 22±1°C and 18±1°C and 65±10% and 75±10% during day and night. After 4 weeks of sowing, they were transplanted in an NFT culture system installed in the room. Shoot fresh weight of Korean mint increased proportionally with increasing PPFDs, showing significant difference. However, rosmarinic acid and tilianin contents per unit g dry weight were the greatest in 200 µmol·m^{-2}·s^{-1} than those of 100 and 400 µmol·m^{-2}·s^{-1} condition. The stem lengths increased proportionally with the photoperiod and the fresh weights was not significantly different at 16, 20, and 24 hours treatments, showing the highest value at 24 hours. Rosmarinic acid and tilianin contents per unit g dry weight at 12 hours photoperiod showed the highest value with significant difference, but least at 24 hours. However, those values per unit a plant dry weight showed the smallest value in 12 hours photoperiod, because of its less biomass. Also 16 hours with 200 PPFD was showed the highest values to produce two phytochemiclas which can be used for health supplements. Under the same DLI condition, the longer the day length, the greater the fresh weight, but the PPFD increased and the functional substance content increased except for the 400 PPFD condition. PPFDs of 200 to 266 µmol·m^{-2}·s^{-1} could be suitable for increasing rosmarinic acid and tiliain accumulated Korean mint with 16 to 20 hours photoperiods without growth inhibition in an indoor farming system.

Effects of Green Light on the Growth and Nutritional Quality of Sweet Basil Under Indoor Controlled Environment *(Poster Board #163)*

Haijie Dou*[1]; Genhua Niu[2] and Mengmeng Gu[1], (1)Texas A&M University, (2)Texas A&M AgriLife Research Center at El Paso, Texas A&M University

Green light can penetrate deeper into plant canopy due to its high transmittance and reflectance than the other wavelengths, while red and blue lights are mostly absorbed by upper-level leaves. Theoretically, substituting partially red or blue light with green light could increase the light penetration to inner canopy, which could potentially increase crop yield. Therefore, we studied the effects of green light on plant photosynthesis, growth, and development in basil (*Ocimum basilicum*) 'Improved Genovese Compact' (green) and 'Red Rubin' (purple) plants grown under indoor controlled environment. A combined red and blue LED ($R_{75}B_{23}G_1FR_1$, the percentage of red, blue, green, and far-red light is 75%, 23%, 1%, and 1%, respectively) was tested as control, and three other treatments were substituting partially red light with green light ($R_{43}B_{24}G_{31}FR_2$), substituting partially blue light with green light ($R_{73}B_{16}G_{10}FR_1$), and substituting partially both red and blue light with green light ($R_{41}B_{12}G_{43}FR_4$). All experiments were conducted in a growth room with the same photosynthetic photon flux density at 224 umol·m^{-2}·s^{-1} with a 16-h photoperiod. Plants were sub-irrigated as needed using a nutrient solution with electrical conductivity of 2.0 dS·m^{-1} and pH of 6.0. The room temperature was maintained at 24.0/21.6ºC day/night. In green basil plants (5 internodes at harvest), the net photosynthetic rate of its upper-level leaves was the highest under $R_{75}B_{23}G_1FR_1$ treatment, while no difference was observed in lower-level leaves. In purple basil plants (7 internodes at harvest), the net photosynthetic rate of its upper-level leaves showed no differences among $R_{75}B_{23}G_1FR_1$, $R_{43}B_{24}G_{31}FR_2$, or $R_{73}B_{16}G_{10}FR_1$ treatments, while the highest under $R_{43}B_{24}G_{31}FR_2$ and $R_{73}B_{16}G_{10}FR_1$ treatments in lower-level leaves. The plant height of both cultivars was increased in $R_{43}B_{24}G_{31}FR_2$ and $R_{41}B_{12}G_{43}FR_4$ treatments. The shoot fresh weight of green basil plants was not affected by green light treatments, while increased in $R_{75}B_{23}G_1FR_1$ and $R_{73}B_{16}G_{10}$FR1 treatments in purple basil plants. The nutritional quality of green basil plants, including concentrations of anthocyanin, total phenolics and flavonoid, and antioxidant capacity of plant leaves, was increased with increasing blue light percentage ($R_{75}B_{23}G_1FR_1$ and $R_{43}B_{24}G_{31}FR_2$), while in purple basil plants, the treatment with increasing red light percentage ($R_{75}B_{23}G_1FR_1$ and $R_{73}B_{16}G_{10}FR_1$) resulted in better nutritional quality.

The Effect of Supplemental Far-Red Light Spectrum on the Canopy Size of Lettuce (*Lactuca sativa*) *(Poster Board #164)*

Reeve Legendre* and Marc W. van Iersel, University of Georgia

Light emitting diodes (LEDs) have many advantages over older lighting technologies, including the ability to control the spectrum of light produced. The light spectrum is an important way plants receive information from their environment and different wavelengths can illicit certain morphological responses to help the plants adapt to their surroundings. Far-red (FR) light (710 – 750 nm) is transmitted through leaves more than 400 – 700 nm light and is a signal indicating that a plant is being shaded by other plants. We determined whether supplemental FR LED lighting can be used to induce a shade avoidance response, increase light interception, and accelerate plant production. Sixty 'Green Salad Bowl' lettuce plants were grown at a 15-cm spacing in 10-cm pots in a growth chamber with eight white LED panels providing a mean photosynthetic photon flux density of 207 ± 13 µmol m^{-2} s^{-1}. Post germination, plants received supplemental light from two custom built FR LED light bars (spectral peak at 735 nm) on one side of the growth chamber, creating a gradient of FR in the growth chamber. The total amount of FR at plant height was the highest directly beneath the LEDs (~ 21 µmol m^{-2} s^{-1}) and diminished the further away the plants were placed (~ 5 µmol m^{-2} s^{-1}). Half of the plants were harvested after 18 days, and the remainder were harvested after 25 days. Canopies of all plants were digitally imaged using an Aris TopView Multispectral Digital Imaging System (Eindhoven, Netherlands) and subsequently phenotyped for projected canopy size using ImageJ (National Institutes of Health, Bethesda, Maryland, USA). Projected canopy size was increased by FR in both harvests ($P = 0.0005$; $P < 0.0001$), as was the total leaf area of the plants for both the first and second harvest ($P = 0.0022$; $P = 0.0005$). Projected canopy size was strongly correlated with total leaf area ($r^2 = 0.91$; $r^2 = 0.89$). The length and width of the longest leaf of each plant also increased, as did shoot dry weight and specific leaf area. An increase in specific leaf area is a typical shade avoidance response. The results from this study suggest that supplementing lettuce with FR wavelengths can increase light interception and expedite the growth of the plants

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Growing Cucumber Seedlings with Broad Spectra Containing Blue Light Results in More Compact Plants with Smaller, Thicker Leaves Than Spectra Lacking Blue Light *(Poster Board #165)*

Nicholas Claypool*, University of California, Davis

Light emitting diodes (LEDs) offer the ability to create customized light spectra for growing plants. As their efficiency continues to increase and price continues to decrease, it is likely that they will represent a larger portion of the horticultural market. This creates a need to understand how various portions of the light spectrum interact with each other to influence plant growth. We grew cucumber (*Cucumis sativus*) seedlings under 8 combinations of blue, green, red, and far-red light to better understand these potential interactions. When part of a broader spectrum, blue light reduced plant height resulting in more compact plants. Blue light also resulted in smaller, thicker leaves, except under monochromatic conditions. Monochromatic blue light resulted in the tallest plants with the highest shoot dry weight and leaf area and lowest compactness. Single-leaf photosynthesis measurements under ambient lighting indicated that blue light increased stomatal conductance, while red and green light resulted in higher photosynthetic rates. This increase in photosynthesis is supported by a higher shoot dry weight in treatments with red light compared to spectra lacking red light.

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The Effects of Biochar, Mycorrhizae and Fertigation on Tomato and Pepper Plants in Container

(Poster Board #166)

Ping Yu*, Taxes A&M University

Biochar (BC) is the byproduct of pyrolysis of biomass. Previous studies showed that the biochar has potential to be used in container substrate at high incorporation rates. It can be beneficial to plants productivity both directly due to its nutrient content and release characteristics and indirectly by improving retention of nutrients. Mycorrhizae (MC) can increase the growth of plants and their nutrition uptake. The objective of this study was to investigate the effects of biochar, mycorrhizae, and fertigation on tomato and pepper plants in container. The container mixes used in this study were formulated by mixing 50%, 70% and 90% pine bark biochar (PBC) with 5% vermicompost (VC) with the rest being commercial substrates, and a commercial substrate was used as control. Tomato and pepper plants were transplanted into one of the treatments on August 8th, 2017 and granular commercial mycorrhizae containing both Endo- and Ecto-mycorrhiza were added to half the containers during transplanting and plants were fertigated with 200 or 300 mg L^{-1} N. Plant growth index (GI) and leave greenness (SPAD) were measured biweekly and at the end of the experiment, shoot dry weight (SDW) were measure. Since no mycorrhizal fungi was found associated with the roots, the treatments with or without mycorrhizae were combined. Biochar and fertigation had no interactions on SPAD, SDW or GI of tomato or pepper plants. For pepper plants, those grown in 90% biochar had significantly lower SPAD, GI and SDW than the others while those grown in 50% biochar and 70% biochar had similar GI and SDW to the control (the commercial substrate). For tomato plants, those grown in commercial substrate had greater SPAD than the others while those grown in 90% biochar had lower SPAD and lower SDW compared to the others. Tomato plants in 50%, 70% or 90% biochar had higher or similar GI compared to control and those in 50%, 70% biochar had higher SDW in comparison to control. No differences were observed for either tomato or pepper plants grown in substrates with or without vermicompost. The biochar used in this experiment could potential replace commercial substrate as container substrate and vermicompost did not provide additional benefits on plant growth.

Evaluation of Specific Ratios of Narrow-Band Blue and Red Led Lights on Plant Growth and Yield of Soilless Cultivated Strawberries *(Poster Board #167)*

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Two experiments were conducted in a greenhouse to evaluate the effects of specific ratios of narrow-band blue/red (447nm/627nm) Light Emitting Diodes (LEDs) on growth and yield of strawberry plants. In Experiment 1, 'Albion' plants were exposed to 7.0°C chilling for three weeks and then transplanted on 27 November 2017 into 3.8 L pots containing a 3:1 mixture of perlite and peat moss. Three single plant pots of each cultivar were placed on separate benches where light treatments would be randomly arranged. The plants were grown in an ebb and flood hydroponic system utilizing a modified Hoaglands nutrient solution. The plants were exposed to six LED light treatments with differing blue/red ratios (10B/90R; 20B/80R; 30B/70R; 40B/60R; 50B/50R; and 60B/40R), a full spectrum LED light, a high pressure sodium (HPS) light, or natural light only. The lights were adjusted to maintain 100 $\mu mols \cdot m^2 \cdot sec^1$ supplemental light from each treatment at the top of the canopy. Beginning on 7 February, the supplemental light treatments were established for 16 h/d (from 5 am to 9:00 pm). The 'Albion' plants were harvested from 15 March until 11 May. The plants were partitioned, and dry weights determined. All plants grown under supplemental LED or HPS lights had numerically greater total fruit yield and total plant dry weights than plants in natural light. Plants grown under full spectrum LED and HPS lights had fruit Soluble Solids Contents (SSC) of 10.3% and 10.0 %, respectively, on 7 May compared to 7.7% for fruit under natural light. A similar trial was established on 5 November 2018, but with six 'Albion' plants in each light treatment. Plants were grown in Milliard 15 cm wide hydroponic slotted pots filled with the same media and exposed to the same light treatments for 16 h/d. Fruit harvest began on 11 January 2019 and has continued until 12 April. Plants grown under full spectrum LED lights had significantly higher number and weight of fruit than plants in natural light. Plants grown under 50B/50R LED, 30B/70 LED lights, and HPS lights produced 85%, 74%, and 69%, respectively, higher yield than plants in natural light. Fruit from plants under HPS lights had significantly higher SSC/acid ratio than fruit in natural light in limited sampling thus far.

Specified Source(s) of Funding: University of Tennessee Institute of Agriculture

Plant Biotechnology 1 (Poster)

Development of Biotechnological Tools to Advance Precision Breeding in Vanilla. *(Poster Board #181)*

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Vanilla planifolia is a high-value crop grown in warm tropical regions that is cultivated for its high-value fruit. Vanilla produces vanillin, a natural product, used in food flavoring, perfumes, and industrial products. Vanilla production however, is limited to few countries that experience significant production challenges that limit world supply and quality, raising the need for improved cultivars and the introduction of novel production systems. In order to advance breeding of Vanilla cultivars with better disease and stress tolerance, flavor and aroma profiles, and horticultural traits better suited to modern production systems, biotechnological tools that can accelerate precision breeding are needed. We are establishing a tissue culture, genetic transformation, and whole plant regeneration platform that incorporates diverse genetic material. Efforts are underway to identify appropriate tissues that are amenable to genetic transformation and whole plant regeneration. We are comparing Agrobacterium and nanoparticle mediated transformation methods, and the use of CRISPR/Cas 9 based gene editing in diverse Vanilla species, cultivars and tissues. One significant challenge to whole plant regeneration are recalcitrant seeds that lack controlled germination. Preliminary results indicate that partially developed seeds derived from immature green-fruiting pods can be germinated under specific media and conditions. Progress towards these goals will be presented and discussed.

Specified Source(s) of Funding: USAID AREA project

Expression and Characterization of Functional Recombinant Mammalian Cytochrome P450 2E1 in Transgenic Gardening Plants *(Poster Board #182)*

Nan-Sun Kim; Hye Ryun An*; Pue Hee Park; Pil Man Park and Su-Young Lee, National Institute of Horticultural & Herbal Science, Rural Development Administration

Cytochrome P450 2E1 (*CYP2E1*) enzyme encoded by *cyp2e1* gene plays an important role in metabolism of heterogeneous organics in mammalian liver cells. The transgenic plant including recombinant mammalian *CYP2E1* gene can metabolize various volatile organic compounds (VOCs). However, it is unclear the mechanism of expression control of *CYP2E1* in plants. In this study, plasmid pCAMBIA2300 harboring the mammalian *CYP2E1* was transformed into *Ardisia pusilla* mediated by *Agrobacterium tumefaciens*. The integration of the *CYP2E1* and *NPTII* genes into the chromosome of the transgenic *Ardisia* plants were verified via genomic DNA polymerase chain reaction amplification. Southern blot analysis revealed the presence of multiple copies of *CYP2E1* in the genome of transgenic plants. Expression of mRNA of *CYP2E1* was confirmed by Northern blot analysis. Western blot analysis indicated 57-kDa of recombinant mammalian *CYP2E1* with 2 putative N-glycosylation in transgenic *Ardisia* plants. The aniline 4-hydroxylase activity of mammalian *CYP2E1* produced from transgenic *Ardisia* leaf was confirmed using aniline as a substrate.

Keywords: Cytochrome P450 2E1 (CYP2E1), Cauliflower mosaic virus 35S (CaMV35S) promoter, *Agrobacterium tumefaciens*, Transgenic *Ardisia pusilla*, Aniline hydroxylase activity

Overexpression of Recombinant Nucleoside Diphosphate Kinase 2 Gene Enhances Tolerance to Various Environmental Stresses in Transgenic Gardening Plants *(Poster Board #183)*

Hye Ryun An*; Nan-Sun Kim; Pue Hee Park; Pil Man Park and Su-Young Lee, National Institute of Horticultural & Herbal Science, Rural Development Administration

Nucleoside diphosphate kinase 2 (*NDPK2*) is known to regulate the expression of antioxidant genes in plants. In this study, transgenic gardening plants expressing the recombinant *NDPK2* gene under the control of an oxidative stress-inducible peroxidase (*SWPA2*) promoter were developed and enhanced tolerance to various abiotic stress conditions. Integration of the *NDPK2* gene into transgenic plant's chromosomes was confirmed by genomic DNA polymerase chain reaction. The level of *NDPK2* mRNA expression and protein in transgenic plants following methyl viologen (MV) treatment was positively correlated with the plant's tolerance to MV-mediated oxidative stress. We observed that transgenic plants expressing the *NDPK2* showed enhanced tolerance to cold, high salinity, and drought stresses.

Keywords: Nucleoside diphosphate kinase 2, Stress-inducible peroxidase promoter, Transgenic gardening plants, Oxidative stress

Elucidation of the Role of 26S Proteasome Subunit PBB2 in Tomato Fruit Development *(Poster Board #184)*

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Proteasomes are protein complexes which degrade unneeded or damaged proteins by proteolysis and play critical roles in the control of plant development and responses to the environment stresses. However, the mechanism of how proteasome mediated targeted proteins turnover during fruit development is still unclear. Here, we tested the function of a core proteasome subunit in tomato. We generated transgenic tomato plants with repression of *Sl*PBB2 in the fruit by RNA interference (RNAi) using a fruit-specific promoter. Down–regulation of *Sl*PBB2 in tomato fruit delayed tomato fruit ripening, induced Blossom-end rot (BER) of tomato and reduced chlorophyll biosynthesis that is positively correlated with the nutrient content and flavor of ripe fruit. These findings provide evidence for the role of proteasome in promoting fruit ripening and establish that *Sl*PBB2 contributes to fruit quality. The underlying mechanisms that lead to the fruit phenotypes will be discussed.

Determining Transmission of the Early Flowering Response from Transgenic Carrizo Citrange Rootstock into Grafted Juvenile Scions. *(Poster Board #185)*

Kawther Aljasim*; Manjul Dutt; Jude W. Grosser and Juliana M Soares, University of Florida

Abstract

Juvenility in Citrus is generally long, usually requiring 4-10 years to achieve flowering and fruit set. In *Citrus*, the *FLOWERING LOCUS T* (*FT*) gene is supposed to be mobile and responsible for flowering. We have produced transgenic Carrizo citrange rootstocks that express the transformed FT gene, resulting in early flowering and fruiting within 18 months. These transgenic plants were propagated using two different methods: 1. An in vitro micropropagation method; and 2. A rooted cutting method. The in vitro method uses MT or MS basal media supplemented with 1-2 mg/l BA with 1500 mg/l malt extract for optimal shoot multiplication. The rooted cutting method uses 1.6% or 3% IBA to achieve optimal rooting. We are testing 6 transgenic lines that test positive for the FT gene; all of these lines flowered and fruited in the greenhouse. To determine if the early flowering trait could be transmitted through a graft union to juvenile scions, we grafted the transgenic Carrizo lines with selected scions from the UF-CREC breeding program, including juvenile triploid mandarin hybrids and diploid grapefruit cybrids. A few of the juvenile scions have quickly flowered and fruited as a result. This suggests successful movement of the FT protein through the graft union into the scion, initiating the early flowering. However, following initial flowering, sustained flowering in the grafted scions has not been observed, although it does continue in ungrafted transgenic Carrizo rootstocks. We have concluded that early flowering in the grafted juvenile citrus scions was because of the movement of FT protein from the rootstock to the scion, but further work is necessary to determine the sustained presence of the FT protein in the scion. Molecular analyses are underway to validate movement of the FT protein across the graft union, and to gain a better understanding of the longer-term effects on the scion.

Dissecting Roles of Auxin Gradient in Tomato Pedicel Abscission *(Poster Board #186)*

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To understand how the temporal and spatial distribution of auxin regulates abscission, a *DR5::GUS* auxin reporter was employed to examine the auxin gradient in the pedicel abscission process in tomato. During the tomato flower development, *DR5::GUS* assay showed that GUS activity was predominantly detected in the vascular tissues and higher on the distal side than the proximal side, suggesting the 'distal-to-proximal' auxin gradient in the pedicel. This gradient was altered during different developmental stages. The lowest GUS activity was detected in the pedicel abscission zone at anthesis stage compared with 2 days before anthesis and 5 days after pollination stages, suggesting that anthesis stage is susceptible to abscission. Auxin depletion by flower removal or auxin transport inhibitor N-1-napthylphthalamic acid (NPA) treatment reduced auxin gradient across the abscission zones and enhanced the abscission process at anthesis. In addition, the pedicel abscission was triggered by high temperature and retarded by low temperature, accompanied by alterations of auxin gradient. The results from analysis of the *DR5::GUS* activity and auxin related gene expression indicated that the reduction of auxin activity occurred before pedicel shedding, and auxin reduction on the proximal side of pedicel may be crucial for abscission initiation.

Development of Stress-Sensitive Artificial Promoters to Control Abscisic Acid Biosynthesis for Enhanced Drought Tolerance in Petunia *(Poster Board #187)*

Stefano Bosio[1]; Huakun Wang[1]; Ayla Norris[2] and Cai-Zhong Jiang*[3], (1)University of California Davis, (2)USDA ARS, (3)USDA-ARS

Abiotic stresses such as low water availability and high salinity are a detriment to agricultural crops, leading to reduced yields. The consequences of water stress in plans include a decrease in cell volume, loss of turgor pressure, an increase of solutes, protein denaturation, and the modification or damage of cell membranes. A primary strategy that plants use to combat and regulate water loss during times of water stress is via abscisic acid (ABA) controlled mechanisms. In the ABA biosynthesis pathway, the enzyme 9-cis-epoxycarotenoid dioxygenase (NCED) is responsible for the rate limiting step, and previous studies have shown that controlling NCED expression is a powerful way to improve drought tolerance. In this study, we have designed two artificial promoters to control a tomato NCED gene for heterologous expression in petunia. Each of these promoters was composed of a repeating string of seven copies of a drought-responsive cis-element: one being 7x Abscisic Acid Response Element (7xABRE) and the other being

7x Drought Response Element (7xDRE). Both of these elements were derived from the promoter of the drought-responsive Arabidopsis gene rd29A, and they represent ABA-dependent and ABA-independent drought response elements, respectively. The expected result would be petunia plants that sense water stress sooner due to the enhanced 7xABRA/DRE promoters, leading to an earlier and stronger increase in NCED expression and therefore ABA-regulated responses. Here, we describe the generation of these transgenic petunias and characterize their responses to water stress.

Specified Source(s) of Funding: USDA ARS

Postharvest 1 (Poster)

Non-Destructive Measurement for Watermelon Fruit Flesh Firmness By Using Surface Elastic Waves *(Poster Board #380)*

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We previously reported that the technique for measuring watermelon texture by using elastic surface waves (ASHS annual meeting 2009). Although previous study provided a useful method for measuring elasticity of watermelon fruit flesh, the method was not able to be used for the screening of a whole fruit, because this was a destructive method. This study aims to develop a non-destructive method to evaluate the elasticity of the fruit flesh.

Surface waves were excited with an oscillator composed of a shaker, a function generator and a power amplifier. In this study we newly employed a laser Doppler vibrometer for detecting surface elastic waves. Signals were recorded with 2 mm increment of propagation distance by moving the sliding stage supporting a laser mirror. The time shifts of the detected peaks were plotted as a function of the propagation distance between the oscillator and the detecting laser, from which the surface wave velocities were obtained. Small-sized watermelons (*Citrullus lanatus* (Thunb.) Matsum. et Nakai) 'Hitorijime-BonBon' with diameter of approximately 16 cm were obtained from a farmer (Ibaraki, Japan).

We obtained velocity dispersion curves for whole fruits in the frequency range of 400–7000 Hz. The velocity in the low frequency limit corresponded to the value for the fruits, the peel of which were removed. This result suggested that we can obtain the velocity for flesh from non-destructive measurement of whole fruit. Also, we made measurements after we kept watermelon fruits in the refrigerator for several days, the velocity was reduced from the value of the fresh fruits, indicating that the firmness was reduced by maturation.

Even we still have to improve the system, we demonstrated the possibility for the non-destructive measurement of the degree of the firmness of watermelon fruit in this study.

Understanding Deterioration of Fresh-Cut Lettuce Under Modified Atmosphere Packaging

(Poster Board #381)

Hui Peng*, University of California-Davis

Fresh-cut lettuce (*Lactuca sativa*) contains nutrients important in human diet, but the product is highly perishable. Modified atmosphere packaging (MAP) with low oxygen (< 3%) is used to maintain shelf life of fresh-cut lettuce. Fresh-cut leaves of many cultivars deteriorate rapidly under MAP, which results in substantial losses and risks of propagation of human pathogens. The rate of deterioration of fresh-cut lettuce under MAP varies among cultivars and differences are highly inheritable. The mechanisms determining the rate of deterioration have not been identified, though a major determinant locus (*qSL4*) was detected on chromosome 4. We found that high respiration induced by low O_2 (< 1%) was highly associated with tissue deterioration, while CO_2 (0-14%) and ethylene (0-10 ppm) had no significant impact on the rate of deterioration of fresh-cut lettuce. Cellular respiration of cut leaves dramatically varied among cultivars when oxygen content was lower than 1% in the salad bag, but when oxygen content was close to 20%, the difference of deterioration rate between rapidly deteriorating (i.e., La Brillante: LaB) and slow deteriorating (Salinas 88: S88) cultivars significantly decreased. RNAseq analysis using S88 and LaB revealed that transcriptomic changes mainly occurred in the initial stages of deterioration rather than later. When comparing the lettuce in the very early stage of deterioration and non-deteriorated one, there were more up-regulated genes (1,837) in LaB than in S88 (1,185). A total of 567 genes were up-regulated in both cultivars. There were 1,735 genes down-regulated only in LaB, and 2,367 only in S88, and 1,060 in both cultivars. Two differentially expressed genes (encoding the disease resistance protein RPM1 and a glycosyltransferase) located in *qSL4* region represent candidates potentially responsible for the rate of deterioration in fresh cut lettuce. Consistent with shelf life tests, genes associated with cellular respiration were expressed differently in LaB and S88 during storage. Genes involved in glycolysis such as two ATP consuming enzymes (fructokinase and hexokinase) and major components of electron transportation chain (ETC), including complex I and IV, and ATP synthase coding genes were up-regulated in LaB but down-regulated in S88. Two alternative oxidase genes that deliver electrons to ETC to reduce oxygen without generating ATP displayed significantly higher expression in S88. These results suggest that susceptibility of cultivars to low oxygen could determine their shelf life. Quality of slow deteriorating genotypes (e.g., S88) is maintained in low oxygen environments by reduced consumption of sugars (i.e., sucrose) and energy (i.e., ATP) and cellular activity, while rapidly deteriorating genotypes (e.g., LaB) act in the opposite manner.

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Postharvest Storage and Nanoparticle Treatment Alter the Bioactive Compounds of Diploid and Triploid Watermelon (*Citrullus Lanatus*) *(Poster Board #382)*

Pratibha Acharya*; G.K. Jayaprakasha and Bhimanagouda S. Patil, Texas A&M University

The nutritional composition of watermelon is influenced by various preharvest and postharvest factors. While application of nanotechnology on nutritional composition and quality has potential benefits, limited studies are available to provide strong evidences. Nanoparticle (silver nanoparticle and turmeric nanoemulsion) treated and untreated watermelons, Riverside (diploid) and Maxima (triploid) were harvested from multi-locations in Texas during two years. The physico-chemical properties and health promoting compounds of watermelons were assessed at ambient temperature 0, 10 and 20 days after harvesting. The results demonstrated the alteration of secondary metabolites of fresh produce leading to the variation of phytochemical composition. It is possible that watermelons continue their metabolic activities after harvest and might have undergone various biotic and abiotic stresses. The physico-chemical characteristics and the levels of bioactive compounds (lycopene, β-carotene, L-citrulline and ascorbic acid) were maintained and/or enhanced in watermelons at 10 days of storage compared to the fresh watermelons. However, in both varieties, levels of all the parameters were significantly reduced in the watermelons held for 20 days. Combined analysis across all locations demonstrated non-significant treatment effect on the physico-chemical and the levels of bioactive compounds among the control and the nanopriming treated Maxima watermelons. Both nanoparticles treated Riverside had significantly enhanced physico-chemical parameters along with the level of L-citrulline and lycopene compared to the unprimed watermelons. No significant difference was observed in the level of b carotene and ascorbic acid level between the treated and untreated Riverside fruits. These observations suggest that seed priming with nanomaterials did not have any toxic effect in the fruit functional quality and that outcomes could depend on cultivar, ploidy level, as well as production location. Similarly, our results demonstrated that watermelon could be stored up to 10 days of harvest without loss of the nutritional quality.

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Membrane Stability Was Associated with Susceptibility/Resistance to Internal Heat Necrosis in Potato *(Poster Board #383)*

Hunter Aliff, West Virginia State University and Ramón A Arancibia*, University of Missouri Extension

Plant resistance/susceptibility to environmental stresses varies among potato varieties. In addition, Ca appears to play a role in membrane stability which appears to be related to internal heat necrosis (IHN), one of the main problems of the chipping cultivar ‘Atlantic’ in Virginia. This study investigated differences in membrane stability and the role of Ca fertilization between two potato varieties that differ in their resistance/susceptibility to (IHN), a disorder that results in the browning of the flesh while still in the field. In addition, the relationship with Ca fertilization was evaluated. Potatoes in this study showed very little or no IHN suggesting that stress conditions were not sufficient to induce IHN. For membrane stability, potato tissue was exposed to increasing temperatures and Electrical conductivity (ion leakage) was greater (P=0.02d) in the susceptible cultivar ‘Atlantic’ over ‘Sebec’ (resistant cultivar) by 38% at 45 °C. There were no differences at any other temperature treatment. This suggests that cell membrane in ‘Sebec’ potato is more stable under heat stress than ‘Atlantic’ and suggest a possible factor in the susceptibility/resistance to IHN. Tissue Ca content was not different among cultivars and treatments, so the association of Ca and membrane stability could not be corroborated. Polyphenol oxidase activity in flesh tissue was higher in ‘Sebec’ than ‘Atlantic’ (P=0.0146). In contrast, there was no differences in peroxidase activity (P=0.1618) and phenolic content (P =0.1065) between the varieties and Ca treated and untreated tubers. In conclusion, results support previous studies that suggested that cell membrane stability is likely a factor in IHN susceptibility/resistance.

Specified Source(s) of Funding: NIFA-SCBG-VA

Effects of Pre-Harvest LED Light, Melatonin and AVG Treatments on Plant Quality of Cut-Snapdragon *(Poster Board #384)*

Chi Dinh Nguyen*, University of Florida/IFAS; Diying Xiang, Mid- Florida Research and Education Center and Heqiang Huo, University of Florida

Snapdragon (*Antirrhinum majus*) is one of top ten fresh cut flowers in the United States; however, its short vase life limits its marketability. The purposes of this study were to test the effects of LED light, exogenous melatonin and AVG during the pre-harvest stage of snapdragon and investigate its possible role in improving flowers quality as well as extending their vase life. Our results showed that the treatment of 10 h white light followed by a 6 h blue light (WB) inhibited stem elongation, lengths of the inflorescences, and reduced the number of florets and vase life. On the contrary, the treatment of 10 h white light, 3 h blue light and 3 h red light (WRB) significantly promoted stem elongation and lengths of the inflorescences, increased flowers size and number of florets. The growth of stem heights and lengths of the inflorescences increased significantly in all melatonin treatments. However, quantity and size of florets were significantly increased with 200 $\mu mol \cdot L^{-1}$ of melatonin treatment, and the vase life was significantly extended as well. In contrast to melatonin, all AVG treatments resulted in decreases of the floret size; and changes in stem elon-

gation and inflorescence length were only observed in the treatment with 100 μmol·L^{-1}AVG. These results showed that the pre-harvest treatment with WRB light or 200 μmol·L^{-1} melatonin can effectively improve the post-harvest quality of cut flowers and melatonin treatment may also extend vase life.

Construction of a Mini-Pack House Using Shipping Containers *(Poster Board #385)*

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Access to cooling and packing facilities is a major limitation for many fresh fruit and vegetable farming enterprises in developing countries including Tanzania. Farmers in Tanzania experience a postharvest loss of 20% to 50% due to poor handling practices and limited availability of packing and cooling facilities. Improper handling practices increase postharvest losses and reduce compliance with quality and safety requirements. Sokoine University of Agriculture (SUA), Kansas State University (KSU) and the University of Florida (UF) are funded from USAID Horticulture Innovation Lab (UC Davis) to build capacity in produce postharvest management in Tanzania. Through this project we designed and established an affordable mini pack house at SUA from used marine shipping containers. The mini pack house consists of 3 shipping containers (2.43 m width (W) x 2.59 m height (H) x 12.2 m length (L), each container has a specific function: receiving, packaging and cooling zone. The cooling zone is divided into two cold rooms (2.43 m (W) x 2.59 m (H) x 6.1 m (L), made by partitioning one of the containers using insulated panels (closed cell foam) with easily cleanable surfaces. Walls and ceiling of the cold rooms were insulated with panels and the floor in all containers installed with Tarazo. Access doors and an 18,000 BTU air conditioner fitted with a Coolbot system were installed in each cold room. The two cold rooms can be set independently to facilitate the different temperature needs for the fresh commodities. The total estimated cost for the mini pack house unit was $8,150, excluding the cost of purchasing the containers, plumbing work, and electricity installation. Since establishment (May, 2018), the unit has been used to train farmers, traders, and SUA undergraduate and graduate students on the best postharvest handling of fruits and vegetables. A total of 86 BSc. Horticulture students taking the postharvest physiology and management class, 60 trainers, and over 100 farmers have been trained. The unit has attracted a number of stakeholders and is now serving as model for dissemination of practical knowledge and skills on postharvest handling of fresh horticultural crops in the country

Specified Source(s) of Funding: USAID Horticulture Inovation Lab UC Davis

Modifying Stomatal Conductance Delays Dehydration but Not Necessarily Postharvest Needle Abscission in Balsam Fir *(Poster Board #386)*

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Postharvest needle abscission poses a challenge to the balsam fir (*Abies balsamea*L.) Christmas tree industry. Literature on the topic has identified numerous causes for needle abscission, such as water deficit, hormonal signals, genotypic variance, and lipid composition changes. However, this experiment focused specifically on changes in stomatal conductance. Stomatal conductance is the rate of transpiration through the stomates and dictates water uptake. Manipulating stomatal conductance could affect needle abscission by increasing or decreasing water uptake, which in turn could affect water status. This study explored this concept through manipulation of balsam fir stomata by several chemical treatments (ABA, fluoridone, BAP, theophylline, potassium nitrate, and dopamine) to determine if any of these compounds had an impact on water uptake, moisture content, and needle abscission. Stomatal conductance decreased by 43% after application of ABA and increased by 28% after application of potassium nitrate. Consequently, the ABA treatment resulted in significantly slower moisture loss while potassium nitrate resulted in significantly higher moisture loss. Despite changes in stomatal conductance and moisture loss, there were no significant changes on needle retention. Needle abscission commenced after an average of 12.5 days and reach 100% completion after an average of 71.9 days. It is possible to manipulate stomatal conductance and water uptake through chemical methods, but this alone is not enough to guarantee superior needle retention. It is proposed that perhaps other chemical signals resulting from root detachment play a critical role in postharvest needle abscission.

Specified Source(s) of Funding: Atlantic Innovation Fund, NSERC, Nova Scotia Department of Natural Resources, Dalhousie University

Propagation (Poster)

Micropropagation of *Cercocarpus Montanus*: Stage II *(Poster Board #195)*

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Cercocarpus montanus (alder-leaf mountain-mahogany) is a species indigenous to the western United States and has a great potential in water efficient landscaping. The objective of this study is to establish a shoot proliferation (stage II) protocol for its production. Nodal segments (≈ 1-2 cm) containing one or two axillary buds were disinfected using 10% ultra-bleach, cultured on an establishment medium of

Murashige and Skoog (MS) supplemented with 1 mg·L^{-1} benzyl adenine (BA), 30 g·L^{-1} sucrose, and 8 g·L^{-1} agar at 25 °C with a 16-hour photoperiod under cool white fluorescent lamps. One month later, there were about 80% clean culture, and new sprouts had four leaves on average. The induced microshoots were subcultured for shoot proliferation on MS medium or Woody Plant Medium (WPM) supplemented with BA, kinetin (KT) or zeatin (ZT) at 1 mg·L^{-1} for 1 month. Both basic medium and cytokinin interactively impacted the number of microshoots (P = 0.02), the length of the longest microshoot (P = 0.04), and growth index (shoot number × shoot length × leaf number; P = 0.03), but this was not the case for the number of new leaves (P = 0.16). On average, about two microshoots and four new leaves were produced on both MS + 1 mg·L^{-1} BA and WPM + 1 mg·L^{-1} KT. *Cercocarpus montanus* grew very slowly in culture. The average length of the longest microshoot produced on MS + 1 mg·L^{-1} BA and WPM + 1 mg·L^{-1} KT was 1.8 and 1.2 cm, respectively. Based on a hierarchical cluster analysis, MS + 1 mg·L^{-1} BA and WPM + 1 mg·L^{-1} KT were better than the remaining four media. Further investigation is needed to determine a superior combination of medium and cytokinin for shoot proliferation of *Cercocarpus montanus*.

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Effect of Auxin Concentration and Stem Position on Propagation of Sequoyah™ Crape Myrtle

(Poster Board #196)

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Crape myrtles provide a reliable source of color for many southern landscapes, often flowering for more than 100 days. Mississippi State University has released six new crape myrtle selections, including Sequoyah™. Sequoyah™ is a hybrid resulting from the cross of *Lagerstroemia* 'Arapaho' and an unknown pollen donor. Sequoyah™ has a clear, true red flower color and medium to large growth habit. Three-year-old plants in a research setting are 4.5+ meters and have flowered from early June through late August. The objective of this research was to evaluate ease of rooting and determine optimal commercial auxin formulation and concentration and stem position for softwood and semi-hardwood cutting propagation of Sequoyah™. Medial cuttings (12.7 cm) were harvested and stuck to a depth of 2.6 cm on 9 April 2018. Medium was 100% perlite in 6.4-cm containers. Treatment factors included auxin formulation [Hortus; Hortus IBA Water Soluble Salts™ (IBA only), Dip'N Grow® (DNG; IBA + NAA with NAA at one-half the rate of IBA), or nontreated control], IBA rate (0, 500, or 1000 ppm), and stem position along the harvested shoots [1 (most proximal), 2, 3, or 4 (most distal)]. Auxin solutions were applied using a basal quick-dip. Experimental design was a randomized complete block design with five replications per treatment combination. Data collected included rooting (Y/N), length of new shoots, cutting quality rating (0-5), root count, average root length (length of three longest roots/3), and root quality rating (0-5). Results showed that number of roots and average length of the three longest roots were similar among treatment combinations. Percent rooted was greater for cuttings dipped in Hortus IBA Water Soluble Salts™ (Hortus IBA) compared to cuttings that received no auxin. Cuttings dipped in Hortus IBA exhibited better cutting quality and larger growth indices compared to cuttings dipped in Dip'N Grow® (DNG). Hortus IBA at a concentration of 1000 ppm IBA resulted in better root quality and growth indices compared to Hortus IBA at 500 ppm IBA, which resulted in higher rooting percentages. In preparing cuttings from a shoot, a cuttings at position 1 was located at the site of attachment to the parent plant (most proximal) and positions 2-4 continued toward the branch tip with position 4 being the most distal. Stem positions 1 and 2 would serve as semi-hardwood cutting types and positions 3 and 4 would serve as softwood cutting types. It was observed that semi-hardwood cutting positions (1 & 2) had higher rooting percentages, root quality, cutting quality, and growth indices compared to the softwood stem positions (3 & 4). Overall, the results suggested that dipping Sequoyah™ semi-hardwood cuttings in Hortus IBA at 1000 ppm resulted in a higher quality liner.

The Impact of Five Grafting Techniques on Success Rate in Pawpaw (Asimina triloba) *(Poster Board #197)*

Matthew Behrends*; Jeremiah Lowe; Sheri B. Crabtree and Kirk William Pomper, Kentucky State University

The pawpaw (*Asimina triloba*) is a fruit-bearing tree native to North America. Its increasing popularity, including among processors, retailers, and restaurants, has led to small-scale commercial production in the United States and worldwide. A large number of wild and seedling pawpaws grown by homeowners and small-scale farmers produce fruit of poor taste, quality, or size. A new advanced selection, Hi7-1, as well as recently released KSU-Chappell™ being studied at Kentucky State University (KSU) have received more favorable reviews for flavor, texture, and appearance than many commercially available varieties. KSU-Atwood™ is a trademarked cultivar developed at KSU that was released in 2009 and is available through licensed nurseries. Whip and tongue grafting and chip budding are common ways to grow desired pawpaw varieties on healthy rootstocks. Grafting can also be performed using tools such as the Topgrafter. T-budding is often used to propagate other fruit and nut species, but is commonly considered unsuccessful with pawpaw; however, this method has not been tested in a replicated study. The purpose of this study was to determine the optimal method and timing for grafting the pawpaw cultivars KSU-Atwood, KSU-Chappell, and Hi7-1. Potted two-year-old trees of each cultivar (n=4/cultivar) were grafted in May using each method (chip, whip & tongue, T-bud, and Topgrafter) at the KSU H.R. Benson Research and Demonstration Farm greenhouses. Additionally, trees were chip budded with green buds of either KSU-Atwood™ or KSU-Chappell™ (n=10) in August to determine the effectiveness of green bud grafting. At the end of the growing season, whip & tongue grafting was the most effective method with a 96% success rate and t budding was the least effective at 37%. Topgrafter and chip budding success rates were 67% and 54% respectively. Grafting success was not significant between different varieties. Survival rates after overwintering will be recorded and discussed.

Specified Source(s) of Funding: SSARE

Asexual Propagation of Half-High Blueberries in Hydroponic Substrates: Cutting Location and Rooting Hormone *(Poster Board #198)*

Jacob D. Schwab*; Kimberly A. Williams and Jason J. Griffin, Kansas State University

For use in hydroponic production systems, blueberries would ideally be propagated in compatible substrates. In summer 2018, softwood cuttings of *Vaccinium corymbosum* x *angustifolium* 'Northland' were rooted. Apical (AP) and basal stem (ST) sections were stuck in rockwool cubes (RC), shredded rockwool (SR), or 3 perlite:1 sphagnum peat moss (v/v; PP). Cuttings were treated with 1,000 ppm IBA (1A), 1,000 ppm K-IBA (1K), 2,000 ppm K-IBA (2K), or distilled water (Control) and were rooted under intermittent mist. Each treatment combination was replicated 6 times with 6 cutting subsamples per experimental unit (e.u.). After 53 days, rooting percentages were calculated and rooting quality was assessed using a 6-point visual scale (0 = dead or no callus, 1 = callus, 2 = few roots, 5 = many roots). AP cuttings had better root ratings than ST (AP 2.7±1.4 and ST 1.9±1.2) as well as better rooting percentages at 80% and 54%, respectively. Root ratings for auxin treatments on AP ranged from 2.6±1.3 to 2.8±1.5 and ST from 1.8±1.3 to 2.1±1.3. Rooting ratings were not different between LR (1.5±0.7) and RC (1.7±0.7), but these were notably lower than PP (3.7±1.2). Differences in substrate rooting percentages were substantial with SR at 46%, RC at 61%, and PP at 95%. Blueberries rooted in hydroponic substrates had no increase in rooting when auxin was applied but had substantially better rooting when apical cuttings were chosen over basal cuttings. The most substantial treatment effect was the type of substrate in which the cuttings were rooted with best rooting occurring in peat:perlite. Despite this, both rockwool substrates could still be used to root blueberry cuttings when the plants will be transplanted into rockwool-based hydroponic production systems.

Specified Source(s) of Funding: USDA - Kansas Department of Agriculture Specialty Crop Block Grant Program

Asexual Propagation of Half-High and Low-Bush Blueberries in Hydroponic Substrates: pH and Fertilization *(Poster Board #199)*

Jacob D. Schwab* and Kimberly A. Williams, Kansas State University

The mature size of half-high and low-bush blueberries is more suitable in hydroponic greenhouse production than high-bush varieties. In fall 2018, *Vaccinium angustifolium* 'Brunswick' (BW) and *Vaccinium corymbosum* x *angustifolium* 'Northland' (NL) cuttings were rooted for 66 days under intermittent mist in substrates compatible with hydroponics systems. Cuttings were stuck in rockwool cubes (RC), shredded rockwool (SR), cococoir (CO), or 3 perlite:1 sphagnum peat moss (v/v; PP). Weekly fertilizer applications of distilled water, 75 ppm N from 16-4-17 OASIS® hydroponic fertilizer or ChemGro three-bag hydroponic fertilizer, were made; all were adjusted to pH 4.0. Each treatment combination was replicated 6 times with 6 cutting subsamples per experimental unit (e.u.); N=432 cuttings for each cultivar. Percent rooting was calculated per e.u., and rooting quality was evaluated using a 6-point visual scale (0 = dead or no callus, 1 = callus, 2 = few roots, 5 = many roots). Electrical conductivity and pH of rooting substrates were measured on pour-through samples collected at final harvest. Cuttings from NL had substantially better rooting percentage (63%) and rooting rating (2.5±1.5) compared to BW (17.8% and 1.3±0.8, respectively). Rooting percentage for both cultivars was lower in the two rockwool substrates (SR at 21.8% and RC at 15.2%) compared to PP and CO (61.6% and 64.4%, respectively). The fertilizer treatments did not affect the rooting rating; EC across treatments ranged from 0.4 to 0.6 dS/m. Both RW and SR resulted in higher pH (7.2±0.2 and 7.1±0.1, respectively) compared to PP and CO (5.5±0.5 and 6.2±0.2). The rooting ratings for these treatments followed a similar pattern: SR was 1.3±0.5, RC was 1.1±0.4, PP was 2.7±1.0, and CO was 2.4±1. Because blueberries prefer acidic substrates, the PP and CO substrates provided more ideal rooting conditions. There was no benefit to applying low rates of fertilizer during propagation. The municipal water used to mist the cuttings had an unbuffered pH of 8.8, therefore the influence of the substrate on altering the pH appeared to influence rooting results.

Specified Source(s) of Funding: USDA - Kansas Department of Agriculture Specialty Crop Block Grant Program

Use of Non- Circulating Containers to Increase Transplant Success in Māmaki(*Pipturus albidus)* *(Poster Board #200)*

Lindsey K. Okumura*; Aimee Taniguchi and Jari Sugano,

University of Hawaii at Manoa
Māmaki *(Pipterus albidus) is* an endemic plant typically found in the understory of Hawaii forests. Historically used by Native Hawaiians for kapa cloth and medicinal purposes, today, there is an emerging market for Māmaki tea. Farmers are trying to meet the demands of the new market but reported high mortality rates after transplanting Māmaki into the field. We replaced the standard round plastic pots with anti- circulating Ray Leach "cone-tainers" or T.O. Plastics Sure Root Plug Trays from Stuewe & Sons to address the concerns. After initial germination, seedlings were transplanted into anti- circulating containers and trays and allowed to root for one month. Following the one month, the rooted plants were then transplanted into the field. Modification of the propagation containers, resulted in transplant success from an initial 10% to 90%. Encouraging vertical root systems and timely transplanting increased the productivity and longevity of Māmaki plants in commercial farming systems.

Specified Source(s) of Funding: University of Hawaii and Smith Lever

Adventitious Root Quantification for Herbaceous Cuttings *(Poster Board #201)*

Benjamin K Hoover*, Cal Poly
Quantifying herbaceous cutting root development can be difficult and time consuming. Conventional methods include dry weights, ordinal ratings, root counts, root lengths, and root area calculations. Dry root weights are often considered the best measure of root growth; however obtaining these values requires washing, drying, and weighing the roots. This is a lengthy and tedious process, and it requires an accurate and precise scale. It is also difficult to connect dry weights to commercial value, such as transplant-ready status. The use of an ordinal rating scale is subjective, but if the assessor is experienced in plant propagation it may provide the most meaningful data relative to commercial value. The use of root scans allows researchers to obtain images of roots, then quantify root development without storing or handling the roots a second time. Scans may be used to generate root counts, root area calculations, and root length calculations. In this study I grew herbaceous cuttings of 6 species (*Achillea* 'Moonshine,' *Ajuga* 'Chocolate Chip,' *Iberis* 'Purity,' *Leucanthemum* 'Western Star Leo,' *Phlox* 'Purple Beauty,' *Salvia* 'May Night') using 7 substrate treatments [1:2 (v/v) Sphagnum peat and coarse perlite or that substrate amended with biochar or sand (0%, 20%, 40%, or 80%; v/v)]. Then I quantified root development via 5 methods [dry root weight, 0-5 ordinal rating (0 = cutting dead, 1 = cutting alive but no root development, 2 = minimal root development, 3 = moderate root development but insufficient for transplanting, 4 = good root development and sufficient for transplanting, 5 = optimal root development), and three methods from excised root scans using ImageJ (primary root count, primary root length, and two-dimensional root area)], then I examined and correlated the metrics and mean comparisons. Calculation of two-dimensional area was very quick and easy. Relationships between quantification methods varied by species. All species had strong positive correlation between root area and root weight (r = 0.99 to 0.73) as well as primary root length and root weight (r = 0.93 to 0.61), but primary root count did not correlate consistently with root weight (r = 0.66 to -0.07). Mean separation ($P \leq 0.05$) of the substrate treatments groups with root weight, root length, root area, and rooting rating measurements showed only minor differences between quantification methods. Excised root scans can quickly and effectively quantify root growth and provide a lasting record.

Specified Source(s) of Funding: Cal Poly CAFES Summer Undergraduate Research Program

In Vitro Performance Evaluation of Two Ginger Cultivars *(Poster Board #202)*

Guochen Yang*[1]; Zhongge (Cindy) Lu[1]; Sanjun Gu[1] and Julia Robinson[2], (1)North Carolina Agricultural and Technical State University, (2)North Carolina A&T State University
Ginger (*Zingiber officinale* Rosc.) is commercially produced exclusively in Hawaii. Seed ginger sourcing has been a challenge for other states in the U.S. In order to help the ginger plant become a viable commodity in North Carolina this research was initiated to explore options for increasing local ginger seed sourcing that is practical and affordable. Towards this goal we have developed a micropropagation protocol for ginger seedling production. Disinfested ginger rhizome buds from two ginger cultivars, Hawaii Yellow (HY) and Kali Ma (KM) were cultured in the Murashige and Skoog (MS) base medium supplemented with 3% sucrose and 0.7% agar, and pH 5.8. The plant growth regulator treatments for shoot initiation and proliferation were MS plus BA, Kinetin, or TDZ combining with NAA. The cultures were incubated in a plant growth chamber at 23°C under 16 hours of light per day. HY performed much better than KM on the same PGR treatment medium, in terms of number of shoots produced per explant and the ranking of regenerated shoots. TDZ induced good callus and shoot primordia (ginger buds) initiation, but only a few shoots. BA produced reasonably good *in vitro* multiple shoot production, but not as good as the kinetin treatment. Kinetin produced the best *in vitro* multiple shoot production, in terms of total number of shoots produced per explant and the shoot ranking. Ginger seedlings were acclimatized in pots containing substrate (1 Metro-Mix 360 and 1 compost) under 80% shade at the University's farm greenhouse. All micropropagated ginger seedlings from this study had a 100% survival rate and grew well with apparently normal morphology. In addition, there appears to be no difference in performance between micropropagated seedlings and the ones produced conventionally from ginger rhizomes.

Photosynthesis of Cuttings Propagated in Over-

head Mist, Submist, and a Combination System
(Poster Board #203)
Olivia Sanchez; Stephanie Burnett and Bryan J. Peterson*, University of Maine
Previous research has shown that submist propagation systems, which apply water only to the basal ends of cuttings inserted into a closed chamber, may produce measures of rooting for *Syringa pubescens* subsp. *patula* 'Miss Kim' (manchurian lilac) that are superior to those of overhead mist. We collected cuttings of manchurian lilac in July, 2018 to evaluate photosynthesis in each system along with a combination system (overhead mist plus submist). Cuttings grown in submist retained the greatest number of leaves. Compared to the overhead mist, the number of roots per cutting was more than five times greater in the combination system and more than three times greater in submist. Root dry weight and root length were greatest among cuttings rooted in the combination system. All traits considered were lowest when cuttings were rooted in traditional mist. Leaf-level net photosynthesis was compared among the three systems using a Li-Cor 6400 portable photosynthesis meter. Photosynthesis was low early in the rooting period (0.8 to 1.2 µmol $CO^2 \cdot m^2 \cdot s^{-1}$) and increased over time to a high of 16.3 µmol $CO^2 \cdot m^2 \cdot s^{-1}$, but did not differ among systems on most measurement dates. The difference in cutting performance among these systems is not due to differences in photosynthesis, so the physiological basis for rooting responses still remains to be determined. Future work will focus on exploring both the feasibility and commercial scalability of submist propagation systems.

Specified Source(s) of Funding: Horticulture Research Institute, National Institute of Food and Agriculture

***In Vitro* Shoot Induction of *Carica Papaya* L. 'Rainbow' Using an Aromatic Cytokinin, *Meta*-Topolin** *(Poster Board #204)*

Jaclyn Nicole R Uy*, University of Hawaii; Richard M. Manshardt, University of Hawaii at Manoa and Teresita D. Amore, University of Hawaiʻi at Mānoa
Production of 'Rainbow' papaya in Hawaii relies on seed propagation, which necessitates culling female plants from commercially desirable hermaphrodites in seedling progenies segregating for sex. Although vegetative propagation techniques such as tissue culture have been developed for cloning hermaphrodites, morphological and physiological disorders caused by culture environment and persistent effects of phytohormones have hindered widespread adoption. Current protocols for in vitro culture of papaya use 6-Benzyladenine (BA), one of the most common cytokinins employed for shoot induction. However, BA has been linked to hyperhydricity, stunted growth, reduced rooting and poor root quality. This study aimed to explore the potential of an aromatic cytokinin, *meta*-Topolin (*m*T), to improve shoot and root proliferation and overall morphology during in vitro culture. 'Rainbow' papaya seeds were germinated in vitro. Nodal segments and shoot tips from the germinated seedlings were excised and cultured in modified Murashige and Skoog (MS) medium containing *m*T or BA at 2.2 µM. After 4 weeks in culture, 85% of the nodal and 100% of the shoot tip explants in 2.2 µM *m*T produced shoots ≥ 1 cm compared to 5.8% of nodal and 100 % of the shoot tip explants grown in 2.2 µM BA that produced shoots ≥1 cm. A 100% reduction in incidence of hyperhydricity was observed in explants cultured in 2.2 µM *m*T. Additionally, subculture of *m*T induced shoots to MS medium devoid of plant growth regulators led to 50% more new shoots produced as compared to BA-induced shoots Moreover, rooting was observed in 30% of the shoots previously cultured in 2.2 µM *m*T. The substitution of *m*T for BA is a useful modification for *in vitro* culture of cytokinin-sensitive plants such as papaya.

Specified Source(s) of Funding: USDA-NIFA Hatch Project

Improving Anthurium Micropropagation Using Thin Cell Layer Culture *(Poster Board #205)*

Teresita D. Amore*, University of Hawaiʻi at Mānoa and Jaclyn Nicole R Uy, University of Hawaii
Micropropagation of anthurium selections for field testing is an important component in the University of the Hawaii breeding program. Generating adequate material for field testing normally takes 3-4 years from callus initiation using newly unfurled foliage leaves or multiplication of accessory buds from greenhouse grown plants. However, some hybrids are recalcitrant in culture, whether from leaf lamina or accessory buds and presents a limitation on current field evaluations. Since thin cell layer culture was not previously used in our breeding program's micropropagation protocol, we attempted to adopt this method for difficult to propagate varieties. Thin cell layers (1mm in thickness) from petioles of newly emerged leaves (leaves not fully expanded) were placed in modified MS medium supplemented with 0.2 mg l^{-1} indole-3-butyric acid (IBA) and 0.1 mg l^{-1} thidiazuron (TDZ) and then incubated in the dark until shoot initials develop. Proembryos (PEMs) emerged within 2-4 weeks of callus initiation. After PEM emergence, the stages of somatic embryo development were observed. In addition, accessory buds and leaves from the microplants were also evaluated as a potential explant source to expedite clonal increase of desired selections for field evaluation

Specified Source(s) of Funding: USDA-NIFA Hatch Project 868H

Establishment and Application of a Virus-Free Sweetpotato Program for Limited-Resource Farmers in Mississippi *(Poster Board #206)*

Yan Meng*; Faith Iseguede; Victor Njiti and Chunquan Zhang, Alcorn State University
Sweetpotato *(Ipomoea batatas* L.) belongs to Convolvula-

ceae family, is an important crop for food security. As one of the top three vegetable crops grown in Mississippi, one major limitation to sweetpotato production is the cumulative effect of virus infection causing cultivar decline and yield losses. Technology such as meristem-tip culture can provide farmers with healthy propagating materials that are free of detectable viruses. However, it has not been well practiced in Mississippi, particularly in the small farms. In this study, we used meristem-tip culture technology combined with heat treatment to produce sweetpotato propagating materials that are free of detectable viruses. In this study, totally 15 lines of sweetpotato have been collected and processed for virus removal. Following laboratory treatment, field practices for virus-tested sweetpotato have been conducted since 2015. Virus-tested sweetpotato demonstration and virus disease diagnostics training were held at ASU field days since 2016. The overall goal of this project is to establish and employ a virus-free sweetpotato program in Mississippi for limited resource farmers, aiming at increasing the sweetpotato yield, quality and investment return for small holders.

Specified Source(s) of Funding: USDA/NIFA

Teaching Methods (Poster)

Teacher's Training Guide, NC Extension Gardener Handbook *(Poster Board #016)*

Lucy K. Bradley*, North Carolina State University

The North Carolina Extension Gardener Handbook Teacher's Guide features a "flipped classroom" model and is based on surveys of successful state programs and NC extension agents. The Teacher's guide contains: pre-homework, an intro PowerPoint to run before class while students are assembling, featuring reviews of previous sessions, teasers for current session, and thought-provoking facts, quiz questions and quotes; a PowerPoint presentation and script; supply list and directions for each interactive station; quiz, homework and field trip suggestions. Students are asked to read the chapter ahead of time and come to class for a brief review of key points before rotating through 6 interactive stations. Each station focuses on a separate objective offering opportunities to experiment, observe, organize and synthesize information through hands-on, role play, and interactive activities and labs that drive home the objectives of each chapter. This replaces the traditional 3-hour power point lecture. The facilitator's guide is full of customizable materials that help instructors easily create a tailored course. This is especially helpful to new agents or those just starting an Extension Master Gardener program in their county as well as public gardens, colleges, nurseries, and prisons that have horticulture training programs and need quality, research-based training materials.

Online, Non-Credit, Asynchronous Learning Opportunities: A Partnership between NC State University and Longwood Gardens *(Poster Board #017)*

Lucy K. Bradley*, North Carolina State University

Three online, non-credit, asynchronous classes on Plant Identification. The courses are offered through the Moodle platform at NC State. Each class focuses on a different group of plants: Edibles, Bulbs and Houseplants; Annuals, Perennials, Vines, and Groundcovers; and Trees, Shrubs, and Conifers. The classes are proctored for six weeks and students have access to the site for an additional six months. Each class is broken into 3 segments with each segment containing a video introduction to the material, additional information including vocabulary, plant profiles, and a pronunciation guide; activities, including flashcards, drag and drop exercises and vocabulary games; assignments including forums to post photographs, and vocabulary exercises; and plant identification and plant cultivation quizzes. There is an optional final exam. Students spend 30 or more hours to complete the course.

Gamification is built into the courses allowing students to earn badges and points as they work through the site. Students can earn a certificate of participation by completing each of the assignments. They can also earn a certificate of mastery by passing each of the quizzes and the final with a score of 70% or higher.

Between 100 and 300 students are trained each year. The statement "overall this course was excellent" received an average rating of 4.41 / 5. A typical student comment, "Great variety of different types of course presentations materials, additional resources, and assignments to reinforce the course goals. Nice to have access to many of these materials after completion the class."

Orchid Grower Certificate Program an Optimistic Approach to the Development of Orchid Production on Guam. *(Poster Board #018)*

Alicja Wiecko*; Kamille Wang and Alexander Chingyan, University of Guam

Orchids represent close to 35,000 species and Guam has a perfect climate to grow many of them. Orchids on Guam are highly desired by both the local population and the 1.5 million annual visitors who expect a tropical island vegetation that includes colorful, exotic flowers. Over the last several decades, most orchids available on Guam were imported from South-East Asia or Hawaii. Propagation on a larger scale is possible only with tissue culture. Unfortunately, few people on Guam possess the knowledge and skills to grow them successfully. Without a larger pool of people acquiring advanced knowledge and ability to produce orchids efficiently, the advantage of less expensive labor in Asia would continue to impede local production by making it unprofitable. Guam Department of Agriculture in collaboration with the University of Guam aims to educate and train workers capable of sustainable production of healthy orchids in quantities sufficient to suppress the influx of foreign plants into the local floral market. In past years DOA concentrated its outreach efforts on employing workers in tissue culture laboratory and orchid nurseries. This was a significant step in training of ordinary workers but potential entrepreneurs were left out. Experience acquired over previous years strongly suggested that the key to establishment of successful and profitable orchid production is education and training of potential entrepreneurs. Many people representing all ages and walks of life desire to become a part of the floral industry and some of them have financial means to peruse their aspirations. They need an opportunity to be walked through the entire process and to gain needed understanding and basic skills. Since the tissue culture laboratory at the Guam Department of Agriculture achieved full capacity to provide needed education and training, we have targeted people who are been motivated by passion to learn rather than employment income. In October 2018, we began to offer free one to two week Orchid Grower certificate programs for small groups, mostly with two participants. Response was overwhelming. Programs run continuously and all slots have been filled six months in advance. Participants are exposed to all procedures and tasks happening in the lab and nursery and after passing a theoretical and practical proficiency exam receive a certificate. The Orchid Grower's certificate program seems to be the most successful step toward development of orchid production that has been undertaken by our program in almost a decade.

Specified Source(s) of Funding: USDA, Agricultural Marketing Service

Capacity Building to Alleviate Postharvest and Marketing Constraints Facing Small-Scale Horticultural Crop Farmers in Kenya *(Poster Board #019)*

David Picha*, Louisiana State University Agricultural Center; Antony Kibe, Egerton University and Mariam Mwangi, Egerton University, Kenya

A training and technical assistance program to address postharvest and marketing challenges facing small-scale limited resource farmers in Kenya was developed through an academic partnership between the Louisiana State University (LSU) Agricultural Center and Egerton University in Nakuru, Kenya. Funding was provided through a USDA-FAS Scientific Cooperation Research Program (SCRP) award. The objectives of the program were to strengthen the capacity of Egerton University faculty and students to conduct postharvest technology research and extension activities to benefit small-scale producers and marketers. The main activities included faculty exchanges, postharvest horticulture training for students and faculty, multiple technical assistance seminars to small-scale farmers, crop-specific postharvest care guides, and export market trade facilitation between Kenyan producers and potential U.S. fruit, vegetable, and floricultural crop importers. The long term goal is to establish a center of excellence in postharvest horticulture at Egerton University for graduate student training and applied research to meet the postharvest challenges of fruit, vegetable, and flower growers and marketers.

Identifying Best Practices for Apprentice Education through a Study of the Growing Growers Program *(Poster Board #020)*

Jesse Gilmore; Candice A. Shoemaker*; Cheryl R. Boyer and Cary L. Rivard, Kansas State University

In 2012, a third of all U.S. farmers were over the age of 65. As the average age of the U.S. farmer continues to rise and these farmers transition into retirement, the industry must find new ways to recruit young farmers. One such method rising in popularity again, (particularly in the organic sector) is apprenticeships, where recruits are placed onto farms to learn agricultural skills from a mentor. While apprenticeships have been studied from a historical context, no study exists on agricultural apprenticeships, how they teach their participants, and whether this educational method leads to increased industry recruitment. This study analyzes survey responses of the apprentices of one agriculture training program in the Kansas City metropolitan area to identify the educational strengths and shortcomings of apprenticeships and develop best practices for apprentice education. Surveys were distributed to past Growing Growers apprentices, who answered questions about learning environments used in the program, as well as skills the program did not adequately develop. The results identified preferred learning environments for fourteen program learning objectives, with patterns emerging for skill-based, object-based, and concept-based learning objectives. Access to land and capital was consistently cited by respondents as the program's largest educational shortcoming, the biggest barrier to starting an agribusiness and the topic that continues to bar those interested in food production from entering the industry. Business and financial management strategies must be taught in such a way that apprentices can contextualize their knowledge, and apprenticeships do not adequately provide this contextual environment. Therefore, granting access to cheap land where apprentices can practice business and financial management in an income-generating environment will prove more effective at educating apprentices than learning these concepts at another farm or through workshops. The use of/access to incubator farms is recommended for apprenticeship programs that desire industry recruitment.

Peas in a Pot: Research-Led Learning in a Crop Physiology Course *(Poster Board #021)*

Sonja Maki*, University of Wisconsin-River Falls

Research-led inquiry is an effective method to reinforce concepts being taught in the classroom. This work highlights an upper level capstone crop physiology course with a term long research experience in phenotyping and modeling different lines of peas presented to students as unknowns at the beginning of the course. The overall objective was to reinforce concepts presented in the lecture portion of the course while experiencing an authentic research experience. Students grew and characterized different lines of pea throughout a course in crop physiology taken by both Crop and Soil Science majors and Horticulture majors in the Department of Plant and Earth Science at UW-River Falls. A packet of unlabeled seeds was given to groups of 2-3 students at the beginning of the course for characterization throughout the term. Each week plant height and age (number of expanded leaves) were recorded from greenhouse grown plants in the Fall of 2018. When plants were age 6-7, plants in one pot were treated with the plant hormone gibberellin A_4 (GA_4) to determine whether a group's line of pea was a gibberellin responding dwarf. Leaf, flower and pod phenotypes were also determined. To address a biotechnology objective of the course, students learned how to design primers to study expression of the *Gigas* gene in a One-Step RT-PCR reaction and then designed an experiment to investigate flowering in their specific line of pea. Overall, this project fostered a sense of exploration and discovery and characterizations of the different lines used in this study will be presented.

Center for Winter Hardy Landscape Plants: Building Landscape Scholars through Experiential Learning and Plant Breeding Research *(Poster Board #022)*

Mary Hockenberry Meyer*; Neil O. Anderson; Emily Hoover and Stan C. Hokanson, University of Minnesota

A logic model was developed by Horticultural Science faculty at the University of Minnesota to articulate the new Center for Winter Hardy Landscape Plants. The Center brings together resources from the Minnesota Landscape Arboretum (MLA), the Minnesota Agricultural Experiment Station, the Department of Horticultural Science, grant partners, and university donors. The Center will provide undergraduate scholarships of up to $2,500 per year for students who complete internships and 25% graduate fellowships for two years for graduate research occurring at the MLA. This new experiential program will compliment the MLA student internship program that has attracted 70 students over 10 years. An additional 1-credit undergraduate class is now offered in Spring semester for undergraduate students in Plant Science or related majors that are selected for the program. This class addresses horticultural issues at the MLA. Students meet MLA staff and work to solve current issues, create new projects and make recommendations for sustainable horticultural practices. In the summer, undergraduate students then complete an internship at the MLA that combines a 40-hr/week-work experience rotating with Landscape Gardeners along with a weekly discussion class. Student interns work on a horticultural or plant breeding project suggested by faculty or MLA staff and present their findings at the end of the summer in an all-staff meeting. Students also learn first hand about career opportunities at a public garden and are encouraged to network with the Arboretum staff. The Center leveraged current resources from scholarships to attract new students into horticultural science, increase visibility for donor's gifts, and strengthen our scholarly work in landscape horticulture and plant breeding. Anticipated outcomes are increased student knowledge of landscape plants and arboreta issues, shared knowledge among partners, increased student involvement in landscape horticulture, and stronger connections between the Arboretum and the department.

Filling Two Needs with One Deed: Enhancing Teaching Experiences for Graduate Students While Simultaneously Enhancing Learning Experiences for Undergraduates *(Poster Board #023)*

Kauahi Perez* and Kent D. Kobayashi, University of Hawaii at Manoa

With today's rapidly changing developments in agriculture and the need to help students keep abreast of new fields and technology, an instructor can have a difficult time keeping current. One possible solution is to utilize graduate students as guest speakers on their own research topics or topics on which they have expertise. The objectives of this study were to determine 1) the effectiveness of having graduate student guest speakers in a tropical crop production systems course as perceived by undergraduate students in the course, and 2) what guest speakers thought of their own guest lecturing experience. Feedback questionnaires were emailed to undergraduate students in the course (coded S1-S5) to determine the effectiveness of graduate student guest speakers. To obtain perceptions of their lecturing experience, separate feedback questionnaires were emailed to graduate student guest speakers (coded G1-G9). Undergraduates reported that they learned something new from each guest speaker. They also felt that these topics were helpful and relevant to their own future jobs. Additionally, undergraduates found it interesting to learn about what students can do beyond a BS degree, felt more comfortable learning from graduate student speakers as compared to having faculty guest speakers, and recommended that the topics and/or speakers be maintained for next year's iteration of the course. Graduate guest speakers were mostly motivated to give a lecture for professional development purposes but also to fulfill a degree requirement. Preparing for their presentations helped them to identify their own gaps in understanding of the topic on which they presented. Graduates felt that it was fulfilling to share their knowledge with undergraduates, and most felt more comfortable giving a talk to undergraduate students as compared to faculty. However, some found it to be more challenging to talk to undergraduates because they perceived faculty as more relatable since they have an enhanced horticultural knowledge base. In conclusion, feedback from undergraduates allowed us to determine which topics to maintain for future iterations of the course. In the future, students in the class should prepare questions for the speaker ahead of time so that guest speakers can gear their presentations toward student interests. Furthermore, having graduate students as guest speakers are effective since our undergraduates feel more comfortable learning from graduate students. Finally, although mostly positive experiences were reported, feedback from graduate students highlighted a common theme shared among graduate students—learning how to communicate science to a diversity of audiences.

Perspectives of Iclicker Technology to Manage Course Attendance in Horticulture and Landscape Architecture Courses *(Poster Board #024)*

Bruce Dunn* and Qing Luo, Oklahoma State University

Class attendance is often positively correlated with exam and class performance. However, instructors often cite not wanting to spend class time recording attendance by calling names, especially in larger class sizes. With the advancement of wireless technology, cell phones, and apps, instructors are now able to access a free, automated method of student-centered tracking of attendance using iClicker technology. iClicker was used in Principles of Horticulture, an introductory course with an average of 50 students, and Professional Practice, an advanced Landscape Architecture course averaging 15 students, at Oklahoma State University in spring 2019. Students were given a five question survey on their perceptions related to their likes, dislikes, attendance behavior, potential to facilitate course learning indirectly, and arrival time. Students cited ease of use, motivation to attend class, ability to monitor their own attendance records, and the ability to always count on it as positives. For negatives, students noted that the GPS function can be glitchy and failure to remember to sign in as negatives. Students in the introductory course self-reported increased attendance and learning related to use of iClicker, but were neutral on the technology resulting in greater on-time arrival. The advanced class did not self-report increased attendance, learning, or on-time arrival to class. For instructors, it provides a record of attendance, if part of academic policy, without using any class time, though instructors should remind students to login each time before class. In addition, an incentive, points related to attendance, could be used to encourage participation.

Vegetable Breeding 1 (Poster)

Salt Leaf Injury Score and Chlorophyll Content Variation Under Salt Stress in Cowpea Seedlings *(Poster Board #258)*

Waltram Second Ravelombola* and Ainong Shi, University of Arkansas

Accurate phenotyping has been a key component in plant breeding and genetics. Improper phenotyping strategy can be money wasting and lead to inaccurate genetics/genomics-related studies in the downstream analysis. Salt leaf injury score and assessment of chlorophyll content have been widely used for evaluating salt tolerance in various crops. Since salinity has been shown to significantly impair cowpea production, developing salt-tolerant cowpea cultivars will be vital. Therefore, the objective of this study was to evaluate salt leaf injury score and chlorophyll content in cowpea seedlings under salt stress. The experiment was a randomized completely block design (RCBD) with 3 blocks and 2 replications for each block, and involved a total of 331 cowpea genotypes including advanced breeding lines from the University of Arkansas, Fayetteville. The experiment was conducted using a previously reported methodology. Two tolerant controls (09-529 and PI582468) and one susceptible check (PI255774) were used. Salt stress was applied when the first trifoliate leaf began to expand and pursued until the susceptible control (PI255774) was completely dead. Salt leaf score injury was based on 1-7 scale as previously reported (1: healthy plants, 7: dead plants). Chlorophyll content was measured before and after salt stress. Salt tolerance index and stress indicator were computed for chlorophyll content. In addition, average dead plants per genotype was evaluated. ANOVA will be conducted and Pearson's correlation coefficient and trend association test between any pair of traits will be conducted using a M^2 test. We expect a large variation in these traits and a good correlation between traits. This study can help improve phenotyping strategy and trait selection for cowpea breeding programs working on salt tolerance.

In Vivo and *in Vitro* Assessment of Na+ and Cl- Contents in Cowpea Under Salt Stress Using Micro Ion Electrodes *(Poster Board #259)*

Waltram Second Ravelombola* and Ainong Shi, University of Arkansas

Soil salinity has been one of the most important factors affecting agricultural production worldwide. NaCl has been showed to be one the most common sources of soil salinity. Effects of salinity on cowpea production have been previously reported. Previous investigations have also demonstrated that high soil Na+ could inhibit the uptake of other essential elements that are required for cowpea plant growth and development. In soybean, Cl- was reported to be a good indicator of salt tolerance. However, the evaluation of Na+ and Cl- using standard techniques could be expensive when a large number of genotypes is to be screened for those ions under salt stress. Therefore, this study will aim to identify Na+ and Cl- in cowpea plants subjected to salt stress at seedling stress using micro ion electrodes. A total of 30 cowpea genotypes selected from a panel consisting of 331 accessions evaluated for salt stress under greenhouse conditions will be used. Of the 30 genotypes, 15 were the most tolerant and 15 were the most susceptible to salt stress among the 331 cowpea panel. Each genotype is replicated six times. *In Vivo* measurement will be achieved by introducing the electrodes into cowpea leaves and stems. This

An asterisk (*) in front of a name indicates the presenting author.

will help evaluate leaf and stem Na +/ Cl- contents and investigate the flow of salt ions within cowpea plant shoot during salt treatment. *In Vitro* measurement of leaf Na+/Cl- using micro ion electrodes will be achieved using a previously described protocol. Data will be collected at one week after salt treatment and at the time when the susceptible control is completely dead, respetively. Data will be analyzed using SAS v. 9.4. We expect a significant discrepancy between the two groups (tolerant and susceptible) based on Na+ and Cl- contents by using micro ion electrode. This study will enhance salt tolerance phenotyping strategy in cowpea and will be completed by an epigenetic study.

Identification of SSR Markers Linked to Nuclear Male Sterility Gene *ms-1* in Muskmelon (*Cucumis melo* L.) *(Poster Board #260)*

Manpreet Singh[1]; Sat Pal Sharma[2]; Navraj Kaur Sarao[2]; Sukhbir Singh[*1] and Rupinder Saini[1], (1)Texas Tech University, (2)Punjab Agricultural University

Nuclear male sterility (NMS) is one of the most extensively exploited pollination control mechanisms for hybrid breeding in muskmelon. Five recessive and non-allelic male sterility genes, *ms-1, ms-2, ms-3, ms-4 and ms-5* possessing unique phenotypes have been reported in muskmelon. An inbred MS-1 containing male sterility gene *ms-1*, refined at Punjab Agricultural University, Ludhiana (India) has been successfully exploited for the development of commercial F_1 hybrids. Since the transfer of a recessive gene is laborious and time-demanding, male sterility gene *ms-1* could not be incorporated to develop new NMS lines. The present study was undertaken to identify codominant simple sequence repeat (SSR) marker(s) linked to *ms-1* gene using an F_2 population derived from a cross 'MS-1 × KP_4HM-15'. Total 498 SSR primers were screened between the parents followed by bulk segregant analysis (BSA). The linkage analysis of 150 F_2 plants using putative primers mapped two SSR markers, DM0187 and DM0038 linked to the *ms-1* gene on chromosome 6. The marker, DM0187 was closely linked at a genetic distance of 6.6 cM while the distance between the *ms-1* locus and DM0038 marker was 21.1 cM. The closely linked marker will be useful for marker-assisted selection (MAS) in muskmelon breeding programs and hybrid seed production, till more tightly linked markers are available. Further, determination of the chromosomal position of *ms-1* gene will be useful for fine mapping and also provide a basis for cloning of this gene.

Inheritance of Papaya Ringspot Virus Resistance from Two Distinct Sources in Tropical Pumpkin (*Cucurbita moschata*) *(Poster Board #261)*

Wilfredo Seda-Martinez[1]; Linda Wessel-Beaver[2]; Jose Carlos V. Rodriguez[1] and Angela Linares Ramirez[*1], (1) University of Puerto Rico, (2)Univ of Puerto Rico

Viruses of the Potyviridae impact all cucurbit crops. Papaya ringspot virus (PRSV) is among the most common of the potyviruses found in Puerto Rico and has been observed to reduce yields of tropical pumpkin (*Cucurbita moschata*) by up to 50%. Two sources of resistance are well known in *C. moschata*: 'Nigerian Local' (NL) and 'Menina' (MEN). The inheritance of resistance from NL has been variously reported as due to a single recessive gene or due to two genes with dominant suppression epistasis. To our knowledge, no inheritance studies have been reported for MEN, nor is it known if resistance to PRSV in NL is allelic to that in MEN. We studied the inheritance of PRSV resistance in mechanically inoculated F2 populations derived from both sources of resistance, and tested for allelism in a NL x MEN F2 population. Susceptible genotypes were 'Verde Luz' (VL), 'Taina Dorada'(TD) and 'TP411' (TP). The second to fourth leaf of inoculated seedlings were rated on a 0 to 4 scale for disease severity and scores were combined to convert to a 0 to 12 scale. F2 populations using NL as the source of resistance had a close to normal distribution with a medium disease severity of 4.5 in NL x TD and 5.0 in VL x NL. In contrast, the F2 populations with MEN were strongly skewed towards resistance with a medium severity of 2.5 in MEN x TD, 0.5 in VL x MEN and 1.5 in TP x MEN. The NL x MEN F2 population segregated 215:23 (R:S) when a severity of ≤ 3 was considered resistant, indicating that NL and MEN resistance genes are not allelic. Segregations in resistant x susceptible F2 populations were variable, depending on how severity scores were combined into the resistant versus susceptible classes. However, most segregations suggested that at least two genes are involved in the inheritance of resistance to PRSV for both NL and MEN. The data clearly indicate that at least some of the genes for resistance in NL and MEN are different. Considering the level of resistance conferred by both NL and MEN, both sources, alone or combined, will be useful in a breeding program.

Breeding Selected Vegetable Crops for Northern Climate *(Poster Board #262)*

Chiwon W. Lee and Suman Parajuli[*], North Dakota State University

The experiment was carried out at the agricultural research station of the North Dakota State University, Fargo, North Dakota during the 2016-2018 summer season in an open field condition. The goal of this research is to develop improved vegetables cultivars with high resilience and broad genetic base that can be best suited for northern plain's region. The research objective was to perform phenotypic selection and evaluate tomatoes breeding lines and cucurbit crops including squash melon and pumpkin. To be specific, the research worked was carried out more on evaluating cultivars on the earliness, nutritional quality, disease resistance, and yield parameters of the selected crops. New cultivars developed in this research will be made available for growers of the local food systems and farmer's markets as well as home growers and the general publics. Breeding lines and germplasm material used in the research was from: 1) tomato breeding lines stored at NDSU since 1980s, 2) Sand Hills Conservation Center, 3) heirloom varieties, 4) accessions available at the National Germplasm Storage Lab, 5) wild species and disease resistant germplasm form Tomato Genetic Resources Centers at University of California-Davis, and 6) donations from research institutions and vegetable seed companies. Out of more than 100 tomato accession lines, we have so far able to select 10 best high yielding, disease tolerant and quality tomatoes line suitable for northern growing. These accessions include tomato plants of different growth habits as well as fruit size , yield and quality.

Specified Source(s) of Funding: ND Department of Agriculture Specialty Crop Block Grant

First Report of *Fusarium Oxysporum* f. Sp. *Lactucae* race 1 in Florida Lettuce *(Poster Board #263)*

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Beginning in the spring of 2017, lettuce plants symptomatic of *Fusarium oxysporum* f. sp. *lactucae* (Fol) were detected for the first time in iceberg lettuce production fields of the Everglades Agricultural Area. Affected plants were chlorotic, wilted, and displayed vascular discoloration along the taproot when sectioned. Plant samples were obtained from four infected fields and isolates were cultured on Komada's semi-selective media. Seventy-eight Fol isolates were harvested and used for pathogenicity testing on the susceptible iceberg cultivar 'Chosen'. Koch's postulates were fulfilled by re-isolating the pathogen from diseased plants on Komada's media and verifying conidia morphology microscopically. Four disease rating experiments were also conducted by planting differential cultivars in infected fields to determine the pathogen's race. Fifty-two of the isolates caused disease in pathogenicity tests, twenty-nine of which were re-isolated to confirm Koch's postulates in 37% of the original isolates. The differential experiments showed a significantly lower disease incidence and severity ($P<0.05$) between the Race 1 resistant cultivar 'Costa Rica 4' and the Race 1 susceptible cultivars 'Patriot' and 'Banchu Red Fire'. The results from our experiments show evidence for a new occurrence of fusarium wilt of lettuce Race 1 in Florida and these results are also being confirmed using Race 1-specific PCR primers. This information will help manage a new threat that could jeopardize around 15,000 acres of lettuce planted just south of Lake Okeechobee, as has occurred in many other lettuce-growing regions worldwide.

Specified Source(s) of Funding: The Hatch Project: FLA-ERC-005599; Foundation for Food and Agriculture Research

Molecular Mapping of Quantitative Trait Loci Associated with Drought Related Traits in Lettuce (*Lactuca sativa*L.) *(Poster Board #264)*

Pawan Kumar[*]; Renee L. Eriksen and Beiquan Mou, USDA-ARS

Drought is a major abiotic stress affecting crop production. Characterization of genetic factors involved in plant response to water deficit is an important step towards breeding for drought-tolerant crops. Lettuce (*Lactuca sativa*L.), one of the major vegetable crops produced in the United States, consists of up to 95% water and is particularly prone to drought stress. To elucidate the genetic architecture underlying lettuce response to different water regimes, we subjected an interspecific F_8 recombinant inbred line (RIL) population derived from a cross between the cultivar Salinas and one of its wild relatives (*L. serriola* accession UC96US23) to optimal water and drought conditions. Drought stress was imposed by withholding water for 21 days when the plants were 4-weeks old. QTL mapping performed using a high-density linkage map comprised of 4,880 SNP markers revealed 21 QTL segregating for drought related traits. The phenotypic variation explained by these QTL ranged from 3.66% for relative water content (RWC) under optimal condition to 22.27% for RWC under drought condition. Wild lettuce accession UC96US23 contributed favorable alleles for the majority of the traits, suggesting its potential importance in introgression breeding for development of drought-tolerant lettuce cultivars.

Specified Source(s) of Funding: California Department of Food and Agriculture

Breeding Lettuce for Resistance to *Impatiens Necrotic Spot Virus* (INSV) *(Poster Board #265)*

Kelley L. Richardson[*]; William M. Wintermantel and Ivan Simko, USDA-ARS

The thrips-vectored orthotospovirus, *Impatiens necrotic spot virus* (INSV), causes economic damage due to spotted wilt disease on lettuce in coastal California. Initial symptoms appear as small brown lesions or spots that expand into larger necrotic sections on infected leaves. Stunted, necrotic, or otherwise symptomatic plants are not marketable; high disease incidence results, therefore, in substantial economic losses to growers. The wide range of host species that can be infected by INSV complicates disease control. Therefore, the best strategy for control is the use of INSV-resistant cultivars. In an effort to develop such resistant lettuce germplasm, our objective was to evaluate the progeny of all possible crosses between plants previously identified as partially resistant or susceptible to INSV. Results of preliminary screenings are presented.

Specified Source(s) of Funding: USDA-ARS

Viticulture and Small Fruits 1 (Poster)

Cane Dieback Disease of Elderberry *(Poster Board #313)*

Michele Warmund* and Jeanne Mihail, University of Missouri

Cane dieback and foliar necrosis caused by an unknown pathogen have been observed in elderberry (*Sambucus nigra* subspecies) plantings in early spring. Studies were conducted to identify the causal organism and determine the effect of infection on vegetative growth and fruiting of selected elderberry cultivars. A *Phoma* sp. was isolated from symptomatic 'Ranch' elderberry canes growing in a commercial planting in Missouri. All canes of one year-old 'Bob Gordon' potted plants inoculated on 10 Mar. with the *Phoma* isolate were symptomatic by 14 days after treatment (DAT). By 150 DAT, cane length of *Phoma* sp.-inoculated 'Bob Gordon' plants was reduced by 65% when compared with the non-inoculated controls. By the end of the growing season, *Phoma* sp.-inoculated canes never flowered or produced fruit. However, each non-inoculated cane developed an inflorescence and produced fruit, averaging 29 g/umbel. When elderberry plants were inoculated on 4 June in a similar experiment, cane length and leaf and leaflet numbers of inoculated 'Bob Gordon' plants were less than non-inoculated controls at 14, 30, and 60 DAT when the study was terminated. The fungus was tentatively identified as *P. novae-verbascicola* based on analysis of genomic DNA from the internal transcribed space region. Thus, the newly reported cane dieback disease, caused by *Phoma* sp., adversely affected plant growth and fruiting of 'Bob Gordon' elderberry.

Plastic Mulches Promote Weed Management and Plant Growth for Floricane Raspberry Planted in Late Summer in Northwest Washington *(Poster Board #314)*

Huan Zhang*[1]; Carol A. Miles[2]; Shuresh Ghimire[3]; Chris Benedict[4]; Inga A. Zasada[5] and Lisa Wasko DeVetter[4], (1) Washington state university, (2)Washington State University, NWREC, (3)University of Connecticut, (4)Washington State University, (5)USDA-ARS

In the Pacific Northwest, dormant roots and canes of floricane red raspberry (*Rubus ideaus*) are traditionally planted in the spring on raised beds. Weed management is achieved through a combination of herbicide applications and hand weeding. However, with the increasing popularity of tissue culture (TC) transplants, there is a challenge associated with their establishment compared to traditional planting materials, especially in regards to weed management. There also has been an increased interest in late summer planting because growers find improved establishment relative to traditional spring planting. Our previous research has shown polyethylene (PE) and biodegradable plastic mulches (BDMs) provide excellent weed control while increasing plant growth and yield in spring-planted TC raspberry. While impacts of plastic mulches in late summer plantings are unknown, there is a concern that mulch may increase populations of root lesion nematode (*Pratylenchus penetrans*; RLN), an important plant-parasitic nematode for raspberry. The overall objective of this study was to investigate whether the benefits of PE and BDMs observed in spring-planted raspberry extend to late summer plantings. One PE mulch, four BDMs (BASF 0.5, BASF 0.6, Novamont 0.5, and Novamont 0.6), and a bare ground (BG) control were evaluated in a commercial 'WakeTMHaven' raspberry field planted in Aug. 2017 in northwest Washington. Mulch performance [as percent soil exposure (PSE)], weed suppression, plant growth, and soil temperature and moisture were measured in 2017 and 2018. Despite a lack of statistical difference, average PSE was 1.4% and 2-15% by Dec. 2017 in the PE and BDM treatments, respectively. Mulch damage observed in 2017 was mainly caused by farm equipment. Mulch continued to be damaged from seven wind events with speeds over 35 km/h from Jan. to Mar. 2018. Damage was most extensive to the BDM plots and therefore all BDMs were removed by Mar. There were no weeds in any of the mulched treatments in Sept. and Oct. 2017, whereas the BG plots had 51 weeds per m2. Average primocane height was greater in the PE mulch treatment compared to all the other treatments except BASF 0.5 in Sept. 2018. RLN populations in soil and roots in Sept. 2018 were low and not different between the treatments. PE mulch could be a management tool for growers planting raspberry in late summer. However, the viability of BDMs for late summer plantings is uncertain due to the damage caused by on-farm activities that were worsened by strong winds.

Specified Source(s) of Funding: Washington Red Raspberry Commission, Washington Commission on Pesticide Registration, Novamont S.p.A, and Washington State Department of Agriculture Specialty Crop Block Grant program, USDA NIFA Hatch projects 0011 and 10/7286.

Supplemental Foliar Nutrients Effects on Fruit Quality and Yield of Two New Blackberry (Rubus sp.) Cultivars *(Poster Board #315)*

Mikel Conway; Zachary Landis; Danyang Liu and Jayesh Samtani*, Virginia Tech

Supplemental foliar nutrient products are applied by some berry growers to improve sugar content, fruit quality and yield; however, there is insufficient evidence that these applications increase fruit quality or yield when applied at the recommended label rates. Virginia growers have limited information on two new thornless, primocane cultivars, 'PrimeArk® Freedom' and 'PrimeArk® Traveler'. These cultivars, studied over two fruiting seasons, beginning in 2016, are considered compatible for hardiness zones 6-9. The study was conducted at the Hampton Roads Agricultural Research and Extension Center (USDA, Zone 8a) with thirty-six (36) PrimeArk® Freedom and PrimeArk® Traveler plants, respectively, established using white woven polyethylene ground cover on raised beds and supported by T-post trellises. The objective of the study was to determine if application of supplemental foliar treatments reflected increases in sugar content, yield and overall fruit quality. Three foliar nutrient treatments were applied using recommended label rates of: AgGrand (4-3-3); K-Ace (0-0-25); Sugar Express® (40-10-40). An untreated control that received no supplementary nutrient was included in the study. Foliar application treatments were applied at various growth stages from pre-bud to bloom through harvest. There were no significant differences between control and those that received foliar treatments, on plant growth, yield, sugar content or overall fruit quality.

Specified Source(s) of Funding: VDACS, USDA Specialty Crop Block Grant

Strawberry Response to Heat Stress Mitigation Differs with Cultivar *(Poster Board #316)*

Trequan M McGee*[1]; Carlene A. Chase[1]; Rebecca L. Darnell[1] and Ali Sarkhosh[2], (1)University of Florida, (2) Univeristy of Florida

Increased yields in November and December, when prices are highest, have the potential to enhance the profitability and stability of the Florida strawberry industry. Transplanting earlier may be a feasible option for generating earlier season yields. However, earlier planting will expose transplants to heat stress. An additional concern for the Florida industry is the large volume of sprinkler irrigation required for bare-root transplant establishment, which could be exacerbated by earlier planting dates. Because Florida-bred strawberry cultivars are not heat stress-resistant, the objective of this study was to determine whether strawberry cultivars in current use in Florida respond in a similar manner to heat stress mitigation with white-on-black plastic (white) mulch plus foliar applications of kaolin. Plug transplants were used to address the secondary concern of water usage for establishment as they can be established with only drip irrigation. Plug transplants are more expensive than bare-root transplants, but higher profit from early yields can offset their higher cost. A split-split plot experimental design was used with planting date as the main plot factor, type of mulch as the subplot factor, and cultivar as the sub-subplot factor. The strawberry cultivars- Florida Beauty, Florida Radiance, and Sweet Sensation® Florida 127- were evaluated at four planting dates spaced two weeks apart across September and October in 2017 and 2018. White mulch plus two applications of kaolin at 0 and 7 days after transplanting was compared to black mulch with no kaolin applications. September planting dates resulted in increased leaf number, crown diameter and number of crowns for both 'Florida Radiance' and Florida 127 when comparing early September dates to October dates. White mulch resulted in higher early season yields than black plastic mulch for the September 6 planting dates, with no difference observed among other planting dates. Early season yield of 'Florida Radiance' was highest when planted on October 4, unlike 'Florida Beauty' and 'Florida 127', which recorded their highest early season yields with the September 6 planting date. Season total marketable yield was lower for all planting dates with 'Florida Beauty' than with the other two cultivars. Although season total marketable yields of 'Florida 127' and 'Florida Beauty' were unaffected by planting date, 'Florida Radiance' produced lower yields when planted in late October. The results indicate that heat mitigation was beneficial only for the September 6 planting date, which enhanced early yields of 'Florida 127' and 'Florida Beauty', but not 'Florida Radiance'.

Effect of Selected Herbicides on the Yield and Berry Size of 'camarosa' Strawberry (*Fragaria x ananassa*) *(Poster Board #317)*

Edgar L. Vinson III*; Steve Li; Floyd M. Woods; Elina D. Coneva and J. Raymond Kessler, Auburn University

Combinational applications of labeled herbicide chemistries is a strategy to enhance weed control in strawberry production. The objective of this study was to assess the benefits of combinational herbicide treatments in terms of strawberry yield and berry size of 'Camarosa' strawberries in hill plasticulture. Pre-emergent herbicides Prowl H_2O and Dual Magnum were applied individually and in combination with Devrinol 50-DF, Sinbar, or Spartan 4F. The latter-mentioned herbicides were applied individually also along with a control. Yield was calculated as mean yield per harvest. Berry weight was determined from the weight of 25 berries divided by 25. The study was a randomized complete block design with repeated measures over dates. The treatment design was a two-way factorial of herbicide treatment and date. Differences among cultivar least squares means were tested using the simulate method. Differences between single applied herbicide treatments to each of their respective combinational treatments were estimated using the simulated method. All significances were at $\alpha = 0.05$. There were no interactions between treatment and harvest date in yield or berry size. Dual Magnum and Prowl H_2O produced yields that were statistically similar to their respective combinational treatments. Though not significant, Devrinol 50-DF + Prowl H_2O combinational treatment produced the largest berries, while Sinbar + Dual Magnum produced berries that were smaller than the control. Pairwise comparisons of Dual Magnum to its combinational treatments showed that there was a benefit provided to yield by combining Sinbar and Dual Magnum ($p=0.0183$), however, Sinbar + Dual Magnum produced the lowest yield numerically and significantly lower than both Prowl H_2O and Prowl H_2O combinational treatments. Conversely, efficacy of Prowl H_2O was not enhanced when combined with Devrinol 50-DF, Sinbar, or Spartan 4F. Berry size of Prowl H_2O and its combinational treatments were greater than other treatments but these differences were not significant. Overall, Prowl H_2O as a stand-alone treatment was the most effective in enhancing strawberry yield and berry size.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant

The Efficacy of Different Combinations of Biological Pesticides for High Tunnel Production of Strawberries in the Mid-South *(Poster Board #318)*

Karlee B. Pruitt, University of Arkansas; M. Elena Garcia, Univ of Arkansas and Russell W. Wallace*, Texas A&M AgriLife Research & Extension Center

The ideal climate for strawberry (*Fragaria x ananassa* Duch.) production is in California. The rest of the country, including the mid-south, grow only a small portion of strawberries in the United States. Consumer demand for organic, locally grown food has increased within the past few years. However, organic, small-scale producers in the mid-south face abiotic and biotic factors that affect production and fruit quality such as rain, disease and arthropods. These problems make organic production, while trying to meet consumer demands, almost impossible to accomplish. One solution to these problems includes the use of high tunnel technologies, which have increased in popularity with small-scale growers. Tunnels provide some protection from the environment, while creating a microenvironment inside of the tunnel. However, some pests such as *Tetranychus urticae* (two-spotted spider mites), *Chaetosiphon fragaefolii* (strawberry aphids), *Podosphaera aphanis* (powdery mildew) and *Botrytis cinerea* (gray mold) can thrive in the high tunnel. Because of these pests, organic growers look for a solution in sustainable pesticides such as biopesticides. Little research has been conducted to determine the efficacy of biopesticides for strawberries in high tunnels. In 2017, the cultivars Sensation and Camino Real were planted as an annual plasticulture system in a Quonset-style Grow Span high tunnel located at the UA Research and Extension Center in Fayetteville, Arkansas. Six combinations of biological fungicides and insecticides were selected as the treatments based on grower's needs. The objective of this study is to evaluate the efficacy of the different treatments to determine how these combinations affect yield, diseases and arthropods. A regular spray schedule was followed with data collected during the months between February and May. This study determine that the treatment combinations had a significant effect in marketable, unmarketable and total fruit yield. Cultivar and date had a significant effect on the mean number of Two-spotted spider mites per leaf, indicating that Camino Real had significantly higher infestations than Sensation. The treatment combinations also showed a significant effect in the number of Two-spotted spider mites per leaf; although all treatments were above the economic threshold of 5 mites per leaf. The percent damage of gray mold indicated that the treatment combinations have a different effect on the two cultivars. The treatment combination of Regalia, Grandevo and Cueva had the greatest disease incidence with Camino Real and the lowest disease incidence with Sensation.

Specified Source(s) of Funding: Southern Region SARE (Sustainable Agriculture Research & Education Grant LS16-275)

Black Root Rot Control with Biofungicide Applications in Two Strawberry Plasticulture Production Systems *(Poster Board #319)*

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Selected biological products for control of black root rot (*Rhizoctonia* spp.) in strawberries grown on two plasticulture systems (high tunnel [HT] and open field low tunnels [OFLT]) were applied October 2017 through June 2018 at the Texas A&M AgriLife Research & Extension Center at Lubbock. Treatments included untreated and chemically-treated (mefenoxam + azoxystrobin) controls, caliente mustard pellets applied in-furrow, and the biologicals Actinovate® (*Streptomyces lydicus* strain WYEC 108), AmyProtec 42 (*Bacillus amyloliquefaciens* strain FZB 42), DoubleNickel® (*Bacillus amyloliquefaciens* strain D747), Regalia® (extract of *Reynoutria sachalinensis*) and RootShield Plus® (*Trichoderma harzianum* Rifai strain T-22 + *T. virens* strain G-41). Treatments were first applied by drenching strawberry plugs at transplanting (except caliente mustard), followed by applying products through a CO_2-pressurized system that delivered treatments through drip irrigation in each microplot at 8 + 16 weeks after transplanting (WAT) or 4 + 8 + 12 + 16 + 20 WAT. Microplots measured 2.5-feet by 10-feet with 20 plants replicated four times and randomized within each plasticulture system. Crop fertilization and pest control were equivalent in both systems. Data were statistically analyzed using the JMP version 14 software (SAS Institute Inc., Cary, NC). While the biological treatments showed no differences, there were differences (p<0.05) between the plasticulture systems. Except percent culls by weight, all other parameters measured including total marketable and cull weights, total fruit weight, plant vigor, biomass and crown number were significantly higher in the high tunnel system. There was a 322% increase in average marketable berry yields in the HT system compared to OFLT plots, which was due to an increased number of harvests in the HT system. Average plant weight and crown numbers were 86% and 67% higher, respectively, in the HT compared to the OFLT plots. However, the number of *Rhizoctonia*-infected plants was 2.3 times higher in OFLT plots compared to those in the HT. These results indicate that the strawberry harvest season was extended in the HT compared to OFLTs, and that the type of plasticulture system influenced *Rhizoctonia* infections, strawberry plant growth, and marketable yield more than did the biological treatments. While HT plots had higher average berry yields and plant growth, they also had fewer *Rhizoctonia*-infected plants suggesting that the HT environment was less conducive to

Rhizoctonia root rot in this trial. A second year of this study is currently under investigation.

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A Rapid Method for Estimating Titratable Acidity in Tomato and Small Fruits *(Poster Board #320)*

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Titratable acidity provides a simple assessment of the potential organic acid content of fruit values and can be related to the sensory perception of sweet and tart. Determining titratable acidity is slow, requiring neutralization of a known dilution of juice/puree with a titrant to reach a colorimetric or pH endpoint. Automated titrimeters speed up analysis, but are expensive and require ~10 min per sample to generate accurate results. Recently digital acid refractometers (acid meters) have become available for fruits and beverages. A very dilute sample solution (1:50) is placed on the acid meter and gives a reading within seconds. Adaptation for regular use has been slow as acid meter readings need to be compared with a titrimeter for accuracy. An acid refractometer (PAL-BX/acid F5, Atago), equipped with settings for 5 commodities of citrus (1), grape (2), tomato (3), strawberry (4) and blueberry (5) and yields results as % titratable acidity in citric acid equivalents was compared for fruits. A dilute solution of 1:50 made with fruit purees was tested on the acid meter and automated titrimeter (862 Compact Titrosampler, Metrohm). Assorted tomato (dominant organic acid= citric acid) purees from breaker, orange, and ripe stages, yielded a linear relationship with R^2 of 0.65. There was one outlier reading that persisted despite re-diluting and running the puree. For muscadine grape ('Cowart'), where citric, malic, and tartaric acid are present, a linear regression with a fit of R^2=0.98 was found between the acid meter (blueberry setting) and automated titrimeter. The blueberry setting was best for blackberry varieties with dominant organic acids of isocitric and citric, yielding a linear regression of R^2= 0.62. For raspberry ('Dorman Red') and black raspberry ('Jewel'), dominant in citric acid, the citrus setting was best, R^2=0.80. Using green, red, ripe, and overripe rabbiteye blueberries, where malic acid dominates, a linear fit with R^2=0.95 was found but acid meter values were 30% higher than titrimeter readings. Benefits of the acid meter are low cost (about USD 1000), pocket size portability, ease of use, lack of hazardous chemicals, rapid measurement, and ability to use under rudimentary conditions. Drawbacks of the acid meter include decreased sensitivity, an occasional high or low reading, and a need to know what the dominant organic acid as a means to adjust for titratable acidity. Overall, the acid meter provides a rapid and feasible means for collection of large data sets of titratable acidity.

Specified Source(s) of Funding: Southern Small Fruits Research Consortium, Hatch

Effective Management of Kiwifruit Ripe Rot Caused By *Botryospaeria Dothidea* in Korea *(Poster Board #321)*

Kwang-Yeol Yang*, Chonnam National University

Effective Management of Kiwifruit Ripe Rot Caused by *Botryospaeria dothidea* in Korea

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In order to find out the effective control methods against the major fungal diseases of kiwifruit grown in Boseong and Haenam regions of Jeonnam provinces in Korea during 2018-19, we have isolated pathogens from rotten kiwifruit during the shelf-life period. Total 107 pathogens species were isolated and only four species were identified as the main pathogens such as *Botryospaeria dothidea, Alternaria alternata*, *Pestalotiopsis* sp. and *Phomopsis* sp., with 32.7%, 26.1%, 26.1%, and 15.1%, identification rate, respectively. Ripe rot caused by *B. dothidea,* was firstly found in overripe kiwifruits (*Actinidia deliciosa*) during a disease survey conducted in Jeju and Jeonnam provinces in Korea in 1999. *B. dothidea* usually infects young fruits by wind-borne ascospores after pollination, but it is also known that the disease does not appear until the fruits begin to be ripen. The common method for ripe rot controlling is fungicide application. However, there are almost rare effective fungicides available for ripe rot management of kiwifruits. It was performed to investigate the occurrence of resistance against fungicides of different classes, which are the most commonly used in the field during the growing period and some of isolated were found to be resistant to a fungicide of a specific class. These results may be helpful in establishing a control system to effectively manage kiwifruit ripe rot.

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Keywords: Kiwifruit ripe rot, *Botryospaeria dothidea*, Fungicide resistance.

Specified Source(s) of Funding: This study was financially supported by the IPET through Kiwifruit Export Research Organization, funded by Ministry of Agriculture, Food and Rural Affairs, Republic of Korea.

Identifying Small Fruit Cultivars for the Northern Great Plains *(Poster Board #322)*

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Consumer interest in antioxidant-rich small fruit is growing nationwide. In Montana, local producers would like to capitalize on this interest, but are limited by high pH soil and a short growing season with severe winters. Several species of fruit with limited current production have potential for production in Montana for local markets. In 2015 we established replicated experimental orchards of multiple cultivars of Aronia (*Aronia arbutifolia)*, Dwarf Sour Cherry (*Prunus Spp*), Saskatoon (*Amelanchier alnifolia*), Haskap (*Lonicera caerulea)*, and Black Currant (*Ribes nigrum*) at three locations in Montana. All have survived well, and we will present data on phenology, yield, fruit quality, and production issues.

Specified Source(s) of Funding: Montana Dept. of Ag Specialty Crop Block Grant

Bioenergy (Poster)

Yes! We Have No Bananas: *Musa Basjoo* As a Potential Bioenergy Crop *(Poster Board #131)*

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Musa basjoo Siebold & Zucc. ex Iinuma (hardy banana; Musaceae) is an herbaceous perennial used ornamentally in temperate climates around the world; it is valued, in particular, for the tropical character of its foliage. Unlike virtually all of its congeners, *M. basjoo* rhizomes and root systems are able to survive moderate durations of freezing temperatures, making it hardy to USDA zone 6a. Given that aboveground portions (pseudostems and leaves) of mature plants can be quite large (5 m in height) but are killed by frost, the plant must replace aboveground biomass annually; we estimated that a mature clone in southeastern Pennsylvania produced 2.2 kg m^{-2} of dry biomass in 2018. To determine if *M. basjoo*'s high productivity could translate into value as a feed stock for bio-oil and biochar production, we conducted an assessment of the plant's chemical composition following fast pyrolysis at 550° C. We quantified 37 products of micropyrolysis using GC-MS in leaf blades, petioles, and pseudostems. The three tissue types had similar volatile product profiles; major compounds in the released volatiles included furfuryl alcohol, 2-hydroxy-3-methyl-1,2-cyclopentandione, 2(5H)furanone, acetol and acetic acid. When compared to switchgrass, there were markedly reduced levels of levoglucosan but greater levels of alkyl phenols and syringols. Nonetheless, the chemical profile of *M. basjoo* is not atypical of herbaceous plants, indicating that it could be a viable means of generating biochar and bio-oil. Future directions will include analyses of pyrolysis products and a viability study of plant growth in the field.

Citrus Crops 1 (Poster)

Comparative Fruit Development and Productivity Among 3 Yuzu(*Citrus junos Tanaka*) Varieties during Growing Season *(Poster Board #298)*

Hye-sung Cho*; Hyeon-ju Jeong; Moon-young Park; Bo-Bae Lee; Youn-sup Cho and In-taek Hwang, Jeollanam-do Agricultural Research and Extension Services
Yuzu is mainly cultivated in south coastal region of Korea and Japan. The total area is estimated as 1,000ha in Korea. Although there are various ways of Yuzu consumption, Yuzu marinated with 50% sugar in volume(YMS) are the most popular in Korea. 59% of YMS produced in Korea is being exported to China in 2016, and the exportation of YMS to the USA has been increasing in recent years. Until now, yellow fully ripe Yuzu fruits were processed for YMS. However, recent studies have shown immature Yuzu fruits contain 2.5 to 6 times more nutrients such as hesperidin and naringin.

In this experiment, the seasonal fruit development and fruit nutrients were monitored from July to November. Three Yuzu varieties (Namhae#1, Wando local, Dajeongeum) were compared. The fruit size of Namhae#1 and Wando local was 2 times bigger than Dajeongeum throughout the season but the seed number of Namhae#1 and Wando local were 20 to 25 per fruit but Dajeongeum has 1 seed per fruit. The rate of fruit flesh was 41% in Namhae#1, 38% in Wando local and 51% in Dajeongeum. In July, the fruit yield per tree was 13kg (590 fruits) in Namhae#1, 13kg (416 fruits) in Wando local and 4kg (329 fruits) in Dajeongeum.

Soluble solid content was very similar as 8°Bx among 3 varieties. Fruit acidity was 3.9%, 3.5% and 4.4% in Namhae#1, Wando local and Dajeongeum. Sugar to acidity ratio was 2.2, 2.2 and 1.8 in Namhae#1, Wando local and Dajeongeum.

Key words : Yuzu, Fruit development, Productivity, Variety

This work was financially supported by Rural Development Administration, Republic of Korea. (Project No. 01382601)

Specified Source(s) of Funding: Rural Development Administration, Republic of Korea

Overcoming Citrus Nursery Growth Issues By Using Smart Lighting with Different Photoperiod Regimes *(Poster Board #300)*

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Nursery citrus trees in California must be grown in insect exclusion facilities to be protected against Huanglongbing (HLB), a deadly disease spread by the Asian Citrus Psyl-

lid. Although faster year-round propagation is critical for citrus nurseries to offset the investment in new exclusion facilities, nurseries currently face serious problems of poor bud push and slow scion growth in fall-budded container grown trees. Therefore, the purpose of this study was to explore the effect of supplemental LED lighting technique on improving container citrus tree growth and propagation efficiency. In this experiment, 144 trees of the common 'Carrizo' citrange rootstock with and without 'Clementine Mandarin' scion were placed in growth chambers under six photoperiod treatments. The treatments were: T1:10 h LED, T2: 10 h LED with low-intensity supplemental night interruption (NI), T3: 10 h LED with high-intensity NI, T4: 10 h LED with high-intensity supplemental light extension of Day length (EoD), T5: 10 h LED with Low-intensity EoD, and T6: 10 h Fluorescent with NI. Light quality of LEDs were adjusted to 80:20 Red:Blue ratio and the trees were maintained in the growth chambers at 28/21 °C day/night temperatures and 65% RH for 12 weeks. The preliminary results of this study showed that there were higher number of leaves and average shoot growth (shoot length, fresh and dry weights) in the LED treatments than the florescent light treatment. Moreover, trees with low-intensity EoD and NI treatments exhibited higher shoot and root growth and chlorophyll contents than high-intensity EoD and NI treatments. Also, it was found that non-budded trees had higher shoot and root fresh and dry weights and lower shoot length than budded trees.

Specified Source(s) of Funding: California Citrus Nursery Board; CSU ARI

Changes in Volatile Components of Satsuma Mandarin(*Citrus unshiu* Marc.) Fruit during Ripening Stages in Korea *(Poster Board #301)*

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Satsuma mandarin has the various flavor components, and the volatile compounds was emitted during ripening stages. This study was conducted to investigate the quantity of volatile compounds until full maturity of fruit for the application of processing materials. The useful compounds of citrus fruit are generally changed from unripe stage to ripe stage such as carotenoids, flavonoids, and volatile compounds. To quantify of volatile compounds at maturity stages, citrus juice was analysed by gas chromatography mass spectrometry. Totally, 31 volatile compounds were detected such as limonene, alpha-terpinen, beta pinene, etc. And Limonene was showed the highest amount as much as 50~75%. 24 volatile compounds were separated toward increasing or decreasing in September. Monoterpene was higher on unripe fruit juice, and sesquiterpene was increasing continuously. Limonene was quantified the highest at ripe fruit juice as much as 70~75%, and monoterpene alcohol and terpene alcohol compounds were also increased. 7 volatile compounds, such as α-terpinolene, α-pinene, γ-terpinene, were decreased in August and September. And 10 sesquiterpene compounds, such as δ-elemene, δ-cardinene, α-cubene, was increased from September to October, then decreased from November. 7 volatile compounds of sesquiterpene and monoterpene alcohol, such as γ-elemene, germacrene, 4-terpineol, dl-limonene, were increased from November to December. That is, These results showed that the volatile compounds were changed during fruit maturity, and the efficiency of application is able to be improved by the decision of optimum processing period for food and cosmetic materials.

Investigating the Cause of Huanglongbing-Associated Preharvest Fruit Drop in Sweet Orange Trees *(Poster Board #302)*

Sukhdeep Singh* and Tripti Vashisth, University of Florida

Huanglongbing (HLB), a citrus disease, due to its endemic presence in Florida has led to a great economic loss in citrus industry within past decade. The HLB symptoms include blotchy mottled leaves, shoot dieback, small and lopsided fruit with aborted seeds and an increase in preharvest drop of mature fruit that occurs up to 3 months before the harvest. The underlying cause of HLB-associated preharvest fruit drop is still unknown. Preliminary experiments suggest that the process of cell expansion and separation in abscission zone at calyx (AZ-C) of mature fruit on HLB-affected tree is similar to that promoted by exogenous ethylene in mature fruits of healthy citrus trees; however, the role of endogenous ethylene in HLB-affected preharvest drop and time of signal transduction pathway is not clear. Therefore, we conducted this study to understand the effect of HLB, role of endogenous ethylene, and molecular mechanism underlying preharvest fruit drop. In this experiment, 'Hamlin' sweet orange trees (n = 4) exhibiting mild, moderate, and severe visual symptoms of HLB were selected and preharvest fruit drop was monitored for approximately 3 months before harvest. Photosynthetically Active Radiation (PAR), as an index of canopy density was measured for each tree and was related with the disease severity level of tree. We found that total preharvest fruit drop rate was significantly related to the PAR values of the trees ($R^2 = 0.71$; p-value = 0.00061). The severely symptomatic trees (high PAR value) had an average of 28% preharvest fruit drop whereas mild trees had significantly lower preharvest fruit drop (15%). The average preharvest fruit drop and fruit detachment force (FDF), although showed similar value in beginning period of monitoring but accelerated significantly in severely symptomatic trees during the course of preharvest fruit drop monitoring. This suggests that disease severity affects the rate of preharvest fruit drop and possibly, signal transduction and HLB interaction occurs during this time period that accelerates the preharvest fruit drop. The next step is to determine the role of endogenous ethylene in HLB-associated preharvest fruit drop by analyzing relative expression of genes involved in ethylene metabolism, abscission, and senescence in AZ-C, leaf, and fruit peel during the preharvest fruit drop time period.

High-Density Grapefruit Production in Open Hydroponics System *(Poster Board #303)*

Rhuanito S. Ferrarezi*; Kayla A. Thomason; Mark A. Ritenour and Alan L. Wright, University of Florida

Precise irrigation and fertigation management provides a better root environment while minimizing excessive irrigation and leaching of nutrients. This concept can improve citrus tree growth in the presence of Huanglongbing (HLB) and help optimize water and nutrient use. Higher tree density can also increase fruit yield per area under high HLB pressure. This study evaluated the efficiency of open hydroponics on 'Ray Ruby' grapefruit production under different irrigation systems and tree density. We tested a combination of rootstocks (Sour orange [SO] and US-897), tree spacing (standard [STD] and high density staggered [HDS]), fertilization (controlled-release fertilizer [CRF] and fertigation [fert]), and irrigation systems (drip and microjet), arranged on five treatments: 1) SO_STD_CRF_MS: SO + standard spacing + controlled-release fertilizer + microjet, 2) SO_HDS_fert_DD: SO + HDS + fertigation + drip, 3) 897_HDS_fert_MS: US897 + HDS + fertigation + microjet, 4) 897_HDS_fert_DD: US-897 + HDS + fertigation + drip, and 5) SO_HDS_fert_MS: SO + HDS + fertigation + microjet. Foliar nutrients, insecticides and fungicides were applied using standard practices and insect pests scouted monthly. HLB incidence reached 100% by five years after planting. The total number of fruit and fruit yield were 226% and 183% higher in 2016 compared to 2015. Trunk diameter and canopy volume increased through time and were higher on SO_STD_dry_MS compared to other treatments due to the higher space available for plant growth. However, SO_STD_dry_MS yielded 7,309 kg/ha in 2017 compared to an average of 22,153 kg/ha for other treatments. High-density plantings tend to increase the yield per area in comparison to yield per tree. Soluble solid content, acidity, and ratio were not significantly different between treatments ($p>0.05$). Total solids per hectare was always lowest in SO_STD_dry_MS. High density staggered planting resulted in higher fruit yield, irrespective of rootstock and irrigation system, representing an important advance to the grapefruit production system. However, labor cost and effects on plant growth over time still need to be determined.

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The Effects of Sunburn on Grapefruit (*Citrus paradisi* cv. Rio Red) Peel Physiochemical Properties. *(Poster Board #304)*

Julissa Rodriguez*, Texas A&M University Kingsville; John Jifon, Texas A&M AgriLife Research Center; Ambrose Anoruo, Texas A&M University-Kingsville and Catherine Simpson, Texas A&M University, Kingsville Citrus Center

Fruit sunburn accounts for approximately 14% of losses in mandarins, up to 40% in apples, and 10-15% in other fruit crops. Sunburned fruit is discolored and exhibits varying degrees of necrotic tissue which reduces fruit quality and marketability. Sunburn occurs on the surface of fruits and are associated with the rupture of glands, phytotoxic injury to tissues and subsequent water loss. Sunburn development is correlated with rising ambient temperatures, high solar radiation, along with other environmental conditions which can cause stress to plants by impacting transpiration, photosynthesis. The degradation of chlorophyll is a major indicator of sunburn damage in fruits. When this occurs, photosystem I and II are affected by high temperatures that disrupt the content and pigmentation of chlorophyll-carotenoid complexes and alter membrane lipids that help prevent photoreduction. Another consequence of high intensities of UV-radiation and temperatures is the development of free radicals in plant tissue. Highly reactive radicals cause damage to the membrane integrity leading to cell death. However, sunburn and the physiological effects it has on fruit tissues have not been studied extensively in grapefruit. Furthermore, very little is known about the changes in peel and juice physiochemistry when fruit are subjected to sunburn. To better understand the role of chlorophylls and other stress response compounds in grapefruit sunburn development (or lack thereof), sunburned and non-sunburned fruit were collected and analyzed for physical properties, chlorophylls, carotenoids, and proline in two consecutive years. We found that there was a significant, positive relationship between chlorophyll B and sunburn severity. Additionally, we found that sunburned fruit had lower proline concentrations and the more severe the incidence of sunburn, the lower the proline concentration. However, total chlorophylls, chlorophyll A, and carotenoids were not significantly affected by sunburn.

Commercial Horticulture (Poster)

Influence of Phosphorus Fertility on Sweetpotato Rooting during Containerized Transplant Production *(Poster Board #045)*

Lee Rouse*, LSU AgCenter

A market for ornamental edible transplants continues to increase for vegetables in the home landscape. As a result, a method for extending the salability of sweetpotato transplants in retail outlets is needed because containerized transplants, especially for root crops such as sweetpotato, can lead to root spiraling and deformation of tubers. Implementing techniques to ameliorate container-bound roots before planting in the landscape are not suitable. Altering phosphorus (P) fertility affects rooting and could be an easy method to slow sweetpotato rooting to limit root spiraling and tuber development. Sweetpotato cuttings were planted in 100% sand filled containers and fertilized at 0, 5, 10, 15, 20, and 31 mg L-1 using a modified Hoagland solution over a 6-week period. Each week, transplant shoots were measured for plant height, quality, and biomass while roots were analyzed for total root length, surface area, volume, average diameter, and biomass. All sweetpotato transplants regardless of P fertility increased in plant height, quality, and biomass for the first three to four weeks followed by declines in transplant quality. Rooting followed a similar pattern for all architectural parameters but continued to increase throughout the duration of the experiments with the exception of the control. In general, as P fertility decreased root growth was slowed. However, fertilizing transplants at the lowest P fertility of 5 ppm did not slow root growth sufficiently to extend the salable period of 4 weeks compared to transplants fertilized at higher P fertilities.

Agrishop Academy Helps Small Farmers in Tobacco-Driven Counties of North Carolina Transition to Heirloom Tomatoes and Baby Ginger Production *(Poster Board #046)*

Sanjun Gu*[1]; Janine Parker[2] and Guochen Yang[1], (1)North Carolina Agricultural and Technical State University, (2) North Carolina A&T State University

Economic distress is higher in counties that were previously tobacco-driven in North Carolina. Small tobacco farmers have been exploring alternative crops to overcome that hardship. Tomatoes have been a traditional cash crop for many small farmers, and heirloom tomatoes can bring even more profit because of their unique flavors and association with heritage. There is at least a $3 more per pound increase for heirloom tomatoes over commercial vine tomatoes. As a niche crop, baby ginger's potential market has been increasing. Its demand has always been higher than the supply. Therefore, baby ginger price ranges from $10-$18 per pound in farmers' market. Both crops serve as potentially ideal alternative crops to tobacco. With grant support from the NC Tobacco Trust Fund, *The AgriShop Academy--Specialty Crops* program was created to educate small and limited-resource farmers of former-tobacco driven counties on heirloom tomatoes and baby ginger from production to market. The goal of this program was to enhance the viability, profitability, and economic stability of North Carolina's small and limited-resource farmers in former-tobacco driven counties. The objectives were to increase production knowledge, marketing knowledge and options, and value-added knowledge of heirloom tomatoes and baby ginger, as well as to teach them the techniques of tomatoes and baby ginger production in field and high tunnels. Four one-day AgriShop Academies were conducted throughout the state of North Carolina from mid-January to early March 2019. Heirloom tomato topics included: tomato basics, heirloom production techniques in field and high tunnels, grafting, marketing, and enterprise budget. For baby ginger, topics covered were: ginger basics, seed source, transplant production, field and high tunnel baby ginger production and harvesting strategy, marketing varieties, marketing price, and value-added ginger products. The workshops reached over 60 small farmers. Post-workshop surveys revealed that the participants were positive about the training and crops, and they gained knowledge from each session. Majority of them either plan or will continue to grow the two crops because of the workshops. Additional in-depth evaluations will be conducted in six months to document participants who have attempted to grow heirloom tomatoes and baby ginger.

Specified Source(s) of Funding: North Carolina Tobacco Trust Fund

Above Ground Root Collar Excavation: Short Term Management Option for Armillaria Root Rot in Peach *(Poster Board #047)*

Sarah B. Miller*[1]; Guido Schnabel[2]; Ksenija Gasic[2] and Bulent Koc[2], (1)Bioagricultural Sciences & Pest Management, Colorado State University, (2)Clemson University

Armillaria root rot (ARR), also known as oak root rot, is currently one of the most threatening diseases affecting stone fruit in the U.S. This soil-borne fungal disease is a primary cause of premature tree decline particularly for peach (*Prunus persica* (L.)) in the Southeastern U.S. The causal fungus in the Southeast (*Armillaria tabescens* (syn. *Clitocybe tabsecens*)) spreads via root-to-root contact, infecting the root system and often killing the tree prior to its maximum productivity. Not uncommonly, trees of 3 and 4 years of age can succumb to the disease on infected replant sites. No proven long-term control strategies exist to eradicate the pathogen. As such, tree losses from ARR on formerly highly productive orchard sites have now reached uneconomical levels; approximately 40% of an orchard planted on an ARR-infected replant site is lost by the time it reaches 10 years of age. With a lack of virgin (i.e., non-replant) land available and no effective means to eradicate the pathogen, an immediate solution is required for the sustainable production of peach trees in the Southeast. Above ground root collar excavation (AGRCE) promises significantly longer tree survival on ARR-infected replant sites than grower standard plantings. In this cultural management system trees are planted on raised beds (berms) and root crowns are excavated after two growing seasons to uncover primary roots and expose the fungus to an inhospitable growing environment. To evaluate influence of the AGRCE planting system on tree survival and productivity, field trials were established in 2011 on ARR-infected replant sites on commercial (Ridge, SC) and research farms (Seneca, SC). Yield and fruit quality (brix, size and firmness), disease incidence and disease severity data were collected at each location from AGRCE orchards and compared to the grower standard plantings. The AGRCE field trials showed significantly lower tree mortality and no difference in yield and fruit quality when compared to grower standard. Even though peach trees eventually succumb to ARR, AGRCE provides an effective management approach to ensure sustainability of the peach industry in the Southeast.

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Changing Agriculture in the Southwestern United States: A Survey of the Arizona Agriculture Community *(Poster Board #048)*

Blase Evancho*; Channah Rock; J L Dery and Dennis T. Ray, University of Arizona

Declining water availability for agriculture in the Southwestern United States necessitates new strategies to sustain rural economies. High-valued crops that are drought and heat tolerant, grow on marginal lands, and provide economic returns will be important under variable future climate predictions. In 2017, the Sustainable Bioeconomy for Arid Regions (SBAR), Center of Excellence, was created to start a research pipeline for crops with a known primary product. This team is working to improve the primary product and identify economic co-products, including cultivation systems, and scalable engineering processes for crop and product processing. Guayule (*Parthenium argentatum*) was identified as the prime candidate to explore for production in Arizona. This woody shrub is native to the Chihuahuan Desert and has been periodically utilized in arid landscaping and for its natural rubber production for over 100 years. Guayule also produces resins and biomass with potential uses as pharmaceuticals, industrial chemicals, and biofuels. These valuable products have created a strong industry backing with high potential for large scale commercial production of guayule in the arid Southwest. To better understand the potential of guayule adoption by growers, we surveyed Arizona's crop producers to collect data on the following topics:

1) Attitude toward growing crops for biofuel production.

2) Attitude and knowledge of guayule.

3) Willingness to change current production system.

We received 113 responses of which 19 were growers. These 19 growers manage approximately 110,000 acres or 10% of the 1.1 million acres of cropland in the state. The surveys were collected at agricultural events held by the University of Arizona Cooperative Extension throughout Arizona to get a wide array of production systems and ideologies associated with crop production. The responses showed a high interest in biofuel production and willingness to change their production system with positive responses to these questions of 67% and 73%, respectively. Sixty-six percent of those surveyed also indicated they had heard of guayule. These and other data collected lead us to believe that there is adequate interest in commercial production of guayule in Arizona. This indicates that our present and future research will be extremely valuable and justified in SBAR's pursuit of establishing a new bioeconomy around this versatile crop.

Specified Source(s) of Funding: USDA-NIFA

Computer Applications in Horticulture (Poster)

Development of a Smart Phone/Tablet Poisonous Plant Application *(Poster Board #042)*

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With its warm and humid climate, Florida landscapes support lush assemblages of native and imported plants, as well as an ever-growing list of invasive exotic species. However, a number of these thousands of plants are toxic, or outright poisonous, to humans, pets, or grazing livestock. Many species commonly planted in Florida landscapes, such as Sago palm (*Cycas revoluta*), dumbcane (*Dieffenbachia* spp.), angel trumpet (*Brugmansia* spp.) and oleander (*Nerium oleander*), are extremely toxic. Further, common weedy invasives in Florida, such as castor bean (*Ricinius communis*) and rosary pea (*Abrus precatorius*), are listed on Florida Exotic Pest Plant Council (FLEPPC) Category I list of invasive plants and are routinely included on myriad online lists of the "world's top 10 deadly plants". Although many poisonous plant treatises, publications, and other resources are available, none are both extensive and specific to Florida. Further, no user-friendly laypersons guides are available for the most poisonous weeds and invasive plants common in Florida. To address this need, a mobile web application was developed that facilitates identification of 166 toxic plants common in Florida residential landscapes and indoor environments, including common landscape plants, weeds, native species, bedding plants, houseplants, and invasives. The app helps users identify the species (plant, weed, etc. – illustrated with 445 photographs), and provides details for each plant including what parts of the plant are poisonous, symptoms of exposure, who is susceptible (people, pets, livestock), toxicity level, and plant-specific notes. As it is a mobile web application, the app may be used on any device, such as a smartphone or tablet, that has internet access. The app facilitates search by plant name, lists of names with thumbnails, or through browsing a plant photo gallery. Further, the app allows filtering by plants toxic to people, pets, or livestock and poisoning symptoms. Plants of interest may be bookmarked. The app is available online through UF/IFAS and has a yearly subscription fee.

Specified Source(s) of Funding: Center for Landscape Conservation and Ecology (UF/IFAS)

A Bioinformatic Platform for Identifying Target DNA Sequences for the Development of Sub-Genome Specific DNA Markers in Polyploid and Other Complex Genomes *(Poster Board #043)*

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The genomes of numerous eukaryotic species are polyploid.

These include several economically important food, feed, and fiber plants, such as strawberry (Fragaria × ananassa), wheat (Triticum aestivuum), and cotton (Gossypium hirsutum). The presence of multiple copies of genes or genomes in a single cell poses technical challenges for the application of high-throughput and next-generation genotyping technologies in breeding and forward genetics research. While sequence duplication often complicates genomic analyses in diploid organisms, this issue is ubiquitous in polyploid research. We studied the problem of identifying unique DNA sequences which are required for developing copy specific high-throughput genotyping assays in organisms where multiple copies of a gene are present. The computational solutions and analyses presented here were motivated by the need to identify subgenome specific DNA sequences in garden strawberry (Fragaria × ananassa), an octoploid originating ~300 years ago from hybrids between octoploid progenitors that originated 0.5-1.0 million years before present. More specifically, our task was to identify suitable DNA sequences for the development of co-dominant PCR-based genotyping assays that are copy specific and avoid amplification of off-target sequences along the genome. Here, we describe the computational solutions and software that emerged from the strawberry study. The software we developed predicts the specificity of DNA sequences for genotyping assay development and considers the presence of variants and indels in a reference population that may adversely affect primer binding sites and amplification products leading to spurious genotyping. In addition, as a guide for designing assays, we formulated a heuristic score which captures the expected quality of the genotyping within a considered population. This software can be applied in any species with a reference genome and benefits from the use of mutation information from high-density SNP array data, whole-genome shotgun DNA sequence data, or a combination thereof. Finally, code optimizations combined with process parallelization makes this software amenable to the large-scale design of PCR-based genotyping assays across an entire genome.

Remote Monitoring of Growth and N Status in Fresh Market Tomatoes *(Poster Board #044)*

Michael A. Metiva* and Zachary D. Hayden, Michigan State University

As unmanned aerial systems (UAS; "drones") have become more accessible over the past decade, interest in their agricultural applications for both production and research have also increased. While considerable research has investigated the utility of UAS-based remote sensing in field crops, comparatively little research has focused on vegetable systems where variation in plant biophysical features and production system characteristics present unique challenges and opportunities. The primary objective of this research was to evaluate the potential for high-resolution multi-temporal aerial imagery to monitor growth characteristics and nitrogen status of fresh market tomatoes. A case study was carried out in 2018 in a tomato nitrogen fertility and cover crop trial at the Michigan State University Horticulture Teaching and Research Center. The background design was a factorial of four rates of N applied to the tomatoes (preplant urea; 0, 56, 112, 168 kg N ha^{-1}) and a legacy of four fall cover crops (none, oilseed radish, rapeseed, hairy vetch), arranged in a split plot RCBD with 4 replications. Tomatoes were grown staked on raised beds with black plastic mulch and drip irrigation. Color imagery was collected at approximately one-week intervals between transplanting and harvest using a DJI Phantom 4 Pro with a 20 MP camera at an altitude of 45 feet, and used to create color orthomosaics and digital surface models (DSMs) at 3-5 mm resolution. Initial processing involved the isolation of pixels which included vegetation using the binary ExGR index in order to exclude background soil/plastic pixels in the subsequent analysis. Three visible-spectrum vegetation indices (BGI, VDVI, NPCI) were calculated as estimates of relative N status, and the DSMs were used to estimate plant heights. Ground validation measurements included plant heights measured at five time points between late June and mid-August, and tomato N status measured by leaf tissue nitrogen concentration and SPAD meter in mid-July, approximately 8 and 9 weeks after planting, respectively. Height estimates were highly correlated overall with measured heights (R^2=0.907, $p<0.001$), and both estimated and measured heights resolved significant N treatment differences over the study period (p=0.0024 and p=0.0067 respectively). N treatment differences were resolved using vegetation indices through July and August, with more significant p-values than SPAD measurements. While more research is required to fully realize UAS utility for tomatoes and other vegetable crops, robust monitoring of biophysical characteristics at high temporal resolution has the potential to support both research data-collection and farm decision-making.

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Floriculture (Poster)

Plant Growth and Flowering of *Schlumbergera truncata I*nfluenced By the Application of Benzylamino Purine and Gibberellic Acid *(Poster Board #372)*

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A variety of flower colors add values on *Schlumbergera truncata* as ornamentals. The quality of *S. truncata* is mainly determined based on the number of phylloclades and flowering at the apical phylloclades. Cytokinins have been shown to promote branching and flowering in Cactaceae. This study was carried out to investigate the effects of growth regulators on the plant growth and flowering on four cultivars of *S. truncata*: 'Orange Candle', 'Pink Dew', 'Red Roman' and 'Snow Queen'. Foliar treatments of benzylamino purine (BA) or both a mixture of BA and gibberellic acid (GA_3) were applied at 100~200 mg·L^{-1} when plants reached to three-phylloclade stage under long-day photoperiod. All plants treated with BA alone or the mixture of BA and GA_3 produced more phylloclades and branches than the control. BA application significantly produced more phylloclades and branches than BA in combination with GA_3. However, BA application shortened the length of phylloclades while adding GA_3 to BA delayed flowering. During the second trial, only BA was applied ranging from 0 to 100 mg·L^{-1} to the plants at two phylloclade stage under long-photoperiod. The number of phylloclades was increased by 19.8~33.0% without shortening the length of phylloclades when BA was applied at 50 or 75 mg·L^{-1} concentration. The number of flower buds was increased by 100 to 190% under short day when BA at 100 mg·L^{-1} was applied on 'Orange Candle' and 'Red Roman', while BA application at 200 mg·L^{-1} increased only from 33.0 to 83.3% in 'Pink Dew' and 'Snow Queen'. The number of flower buds increased with the higher concentration of BA, but the number of days to flower decreased and the length of flowers was shortened. In conclusion, the only BA application appears to be more effective in order to increase the number of phylloclades and flower buds in *S. truncata.*

This study was carried out with a support from the Korea Rural Development Administration (RDA) (Project No. PJ012635).

Effects of Volumetric Water Content on Growth and Photosynthesis of *Platycerium Wandae* *(Poster Board #373)*

Chun-An Liu*, National Taiwan University

Effects of volumetric water content on growth and photosynthesis of *Platycerium wandae*

Chun-An Liu* and Der-Ming Yeh

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Staghorn ferns are high valued and have been used extensively in many areas for landscaping, with great potential for markets' demands. However, staghorn ferns grow slowly because they thrive as epiphytes in the forest canopy with fluctuations of water availability in distinct wet and dry seasons. A better understanding of their water requirement would facilitate faster production. In this research, plants of *Platycerium wandae* Racif. with two sterile fronds were grown with a potting medium of 2 peat moss: 2 vermiculite: 1 perlite (by volume). Growth and photosynthesis were measured in plants under 30% volumetric water content (VWC), 70% VWC (moisture), 20% VWC (drought), and 20/70% (drought/moisture) VWC treatments for three months. Results show that plants under 20% VWC had the lowest dry weight, frond area, net photosynthetic rate, and stomatal conductance, but highest internal CO_2 concentration. Therefore, long-term drought stress led to slow growth through both stomatal and non-stomatal limitation. Plants under 30% VWC and 70% VWC did not differ in growth and photosynthesis. Plants under 20/70% VWC had the highest dry weight and net photosynthetic rate, and the largest frond area due to the appearance of rapidly bending sterile fronds. Chlorophyll fluorescence measurements, such as Fv/Fm, did not differ among the four VWC treatments.

Genome-Wide Analysis of NBS-LRR Genes in *Petunia* *(Poster Board #374)*

Ze Peng* and Zhanao Deng, University of Florida

Petunia hybrida is an important flower in the floriculture industry. Fungal and virus diseases pose a major threat to petunia plants in commercial production and landscape use. Improving disease resistance has become an important objective in petunia breeding. The nucleotide-binding site leucine-rich repeat (NBS-LRR) genes play an important role in recognizing pathogens and conferring disease resistance in plants. The released genomes of *P. axillaris* and *P. inflata*, the two parental species of *P. hybrida*, have made it possible to conduct a comprehensive characterization of this group of disease resistance genes in *Petunia* in a genome-wide manner. Using multiple bioinformatic tools, we discovered a total of 267 and 388 NBS genes in the genomes of *P. axillaris* and *P. inflata*, respectively. These NBS genes were characterized for the presence of the Toll/Interleukin-1 receptor (TIR), coiled coil (CC) and/or LRR domains. For all classes of NBS genes, there are more genes in *P. inflata* than in *P. axillaris*. Surprisingly, most of the *Petunia* NBS genes are of the non-TIR type, and only very few of the TIR type. More than half (55.9%) of the NBS genes contain the LRR domain while the remaining lack a typical LRR region. *P. inflata* has 146 CC-NBS-LRR genes, more than double of the number (68) in *P. axillaris*. With further phylogenetic and gene expression analysis, our study shall provide important insights into disease resistance in *Petunia* and a valuable genomic resource for future improvement of disease resistance in this important flower. This resource may enable *Petunia* to become a new model system for molecular genetic study of disease resistance genes in plants.

Specified Source(s) of Funding: USDA-NIFA Hatch project FLA-GCC-005507

Carbohydrate Pulses Hasten Flower Opening, but Do Not Improve Freezing Tolerance of Cut *Paeonia Lactiflora* Pall. Hybrids *(Poster Board #375)*

Nathan Jahnke*; John M. Dole and David Livingston III, North Carolina State University

Cut flowers of *Paeonia lactiflora* Pall. (peony) hybrids, can be stored dry for multiple weeks between 0 and 1 °C. However, vase life and flower quality often decline following 4 or more weeks of storage. Cut peonies may be adaptable to sub-zero storage because stems and buds often experience freezing temperatures prior to harvest. To determine freeze tolerance of cut peonies: cut stems of three peony cultivars: Karl Rosenfield, Monsieur Jules Elie, and Sarah Bernhardt, were either left untreated or pulsed with water, 100 $g \cdot L^{-1}$ sucrose, or 100 $g \cdot L^{-1}$ fructose prior to holding stems at either 0, -2 or -4 °C for 4 h. Pulse treatments did not improve vase life of any cultivar. Sucrose-pulsed stems of ‘Karl Rosenfield’ and ‘Sarah Bernhardt’ had the lowest total vase life, a summation of the number of days in the bud or open flower stage. Pulsed and cold-treated stems of ‘Karl Rosenfield’ and ‘Monsieur Jules Elie’ opened 2 to 3 d and 0.5 to 1 d, respectively, earlier than untreated, control stems. Cold treatment did not affect bud opening or open vase life of ‘Sarah Bernhardt’. Freeze injury ratings were expressed as water-soaked spots on petals; stems and leaves were uninjured. Petals were not injured by freezing temperatures when stems were kept dry and not pulsed. Injury was greatest for all cultivars when stems were held at -4 °C. Fructose-pulsed stems of ‘Karl Rosenfield’ and ‘Monsieur Jules Elie’ had the highest injury ratings. Pulsing did not affect ($P \leq 0.1638$) injury ratings on ‘Sarah Bernhardt’. An infrared camera was used to observe supercooling and multiple freeze events in stems, leaves, and buds held at -4 °C. Primarily, ice nucleation started at the base of the stems. Ice propagation then occurred throughout the stem, leaves, and bud within 1 to 2 minutes of initiation. Stems that were not pulsed remained in a supercooled state longer than those that were pulsed. These findings indicate that storage temperatures between 0 and -2 °C may be a valid option to extend cut peony availability.

Specified Source(s) of Funding: North Carolina Specialty Crop Block Grant Program

Mid-Winter Daylight Extension with LED Lights Improves Rooting of Herbaceous Annuals and Perennials *(Poster Board #376)*

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Successful rooting and establishment of herbaceous bedding plants during mid-winter in the greenhouse can be a challenge due to photoperiod, nutrition, and other environmental variables. This trial focused on supplemental LED light spectrum and its effects on adventitious rooting of five cultivars of annuals, and five cultivars of perennials. Unrooted cuttings acquired through a commercial broker were stuck into rooting cubes and placed under intermittent mist in a polycarbonate greenhouse in late January 2018. Two supplemental light treatments and one treatment with no supplemental light were used. The first supplemental light treatment used Philips DR/W/FR (deep red/white/far red) GreenPower LED toplight modules and with the second Philips DR/W/MB (deep red/white/medium blue) GreenPower LED toplight modules. Each supplemental light treatment provided 90 $\mu mols \cdot m^2 \cdot sec^2$ photosynthetic active radiation (PAR) as daylight extension for 8.5 hours each day. After two weeks each plug was examined, and the number of visible roots were counted and once again one week later. All species had greater number of roots under supplemental light. Geranium and rosemary cuttings generated more roots under DR/W/MB compared to DR/W/FR and no supplemental light, respectively. Osteospermum, phlox, salvia, and scaevola cuttings generated more roots under DR/W/FR. Leucanthemum rooted more quickly under DR/W/MB, but one week later, rooting under both supplemental light treatments were similar. Calibrochoa, iberis, and sage rooted similarly under both light treatments, but rooting was greater compared to supplemental light. Our results indicate that supplemental light improves the initial rooting under mid-winter greenhouse conditions. The spectra for best rooting is dependent on cultivar.

Updating Poinsettia Graphical Tracking Curves for Greenhouse Growers *(Poster Board #377)*

Karen K. Schneck; Kimberly A. Williams*; Danielle Haynos and Rachel Peterson, Kansas State University

Graphically tracking poinsettia crops is a valuable tool to guide grower management of crop height. As new poinsettia cultivars have replaced those that were used to generate the target ranges for the original graphical tracks, updates are warranted. In addition, cultivar responses to production factors such as plant growth regulator (PGR) applications and late season stretch can be incorporated into versions of graphical tracks to aid growers in anticipating plant response. *Euphorbia pulcherrima* ‘Ferrara’, ‘Holly’, ‘Premium Marble’, ‘J’Adore Pink’, ‘Prestige’, ‘Titan Red’, and ‘Christmas Spirit’ were potted in 6.5-inch pots and grown in two DIF environments (+5 and +9) during Falls 2017 and 2018. All plants were tracked bi-weekly until harvest. Effect of a range of application rates of PGRS on growth curves were evaluated on both ‘Ferrara’ and ‘Titan Red.’ Interestingly, our results suggest that the current S-shaped graphical track could be optimized to better represent the growth curves of these poinsettia varieties when grown in either +5 or +9 DIF environments. A strategy for growers to minimize the complexity of managing graphical tracking of multiple cultivars is to use standard curves across three vigor groupings (low, moderate, and high) suitable for the wide range of poinsettia cultivars available in the market today.

Specified Source(s) of Funding: Fred C. Gloeckner Foundation

Evaluating the Interaction of Temperature and Photoperiod on Poinsettia Flowering *(Poster Board #378)*

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Poinsettia (*Euphorbia pulcherrima*) flowering can be delayed by exposure to supra-optimal temperatures – a phenomenon termed “heat delay”. The objective of this research was to

An asterisk (*) in front of a name indicates the presenting author.

evaluate the interaction of temperature and photoperiod on poinsettia flower development. The experiment included three day temperatures (20, 24, and 28 °C), four night temperatures (16, 20, 24, and 28 °C) and five night lengths (10, 11, 12, 13, and 14 h) for a total of 60 treatment combinations. After 17 d in the temperature and photoperiod treatments, all plants were moved to one greenhouse with an inductive environment (14-h nights and 24 °C day/20 °C night temperatures). Two cultivars were used for this experiment – Orion Red (heat tolerant) and Prestige Red (heat sensitive). Time to first color, visible bud, and anthesis were recorded. Progress to anthesis (days/flower) was calculated as the reciprocal of days to anthesis. At the 10 h night length, no progress to anthesis occurred for either cultivar. For Prestige Red, progress to flower increased as night length increased from 11 to 14 h and as night temperature decreased from 28 to 20 °C. Providing long night lengths with black curtains during September is often viewed as a technique to avoid heat delay. Our data demonstrate that growing Prestige Red with a 13 or 14 h nightlength will reduce the time to anthesis when compared to natural night lengths of 11 to 12 h that occur September. However, high night temperatures will cause a significant delay in flowering when compared to more moderate temperatures even when poinsettias are provided a 13 to 14 h night length. Orion Red did not demonstrate a delay in flowering at high night temperatures, and the rate of progress to flower increased at a higher rate at shorter night lengths, e.g., 11 and 12 h, than Prestige Red. This explains why Orion Red is categorized as an early-season cultivar that normally flowers in early November while Prestige Red is a late-season cultivar that flowers in late November when grown under natural night lengths. A model to predict flower development based on ambient temperatures and photoperiod will be presented.

Specified Source(s) of Funding: USDA-ARS-FNRI

Measuring Tissue Nitrogen (N) Content Using Smart Phones *(Poster Board #379)*

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Optimal level of tissue nitrogen (N) is crucial for growth and quality of ornamental plants. Laboratory analysis is the only direct method available to growers to accurately measure tissue N. However, this method is time-consuming. Other equipment like SPAD or chlorophyll meter are expensive. The objective of this study is to develop easy and affordable technology for measuring N status of single or group of plants. Tissue N affects chlorophyll content in plants and thereby influences plant absorption/reflectance of light. A relatively inexpensive (approx. $150) N-sensor that can be connected to a smartphone or computer was built using a micro-controller, two miniature cameras and light filters to measure reflectance of red (R) and near infrared (NIR) light from plants. An experiment was conducted to test the efficacy of the sensor to measure tissue N in four poinsettia (*Euphorbia pulcherrima)* cultivars (Christmas Glory White, Christmas Tradition, Christmas Beauty Marble and Wintersun White) by growing them under five levels of fertilizer concentration (112.5, 225, 375, 525 and 675 mg·L^{-1} N). Software was developed for capturing, processing and extracting reflectance from images using Matlab and C++ languages. Measurements included ratio of reflectance from R and NIR images (R_{ratio}), shoot dry weight (g), and elemental analysis of plant tissue including tissue N content. Results indicated a curvilinear relationship between SDW and fertilizer concentration with maximum SDW at 375 mg·L^{-1} N. There was a linear relationship between tissue N obtained from the laboratory and R_{ratio} for different varieties ($0.66 < r^2 < 0.78$). The fitted stepwise selection model ($r^2 = 0.70$) indicated that, among other elements, N explained most of the variation in R_{ratio} (partial $r^2 = 0.60$), while other significant elements including S, Na and Ca had minimal contribution to the ratio (combined $R^2 = 0.1$). To further understand basis for R_{ratio}, a separate study was conducted using three varieties (Christmas Glory White, Christmas Tradition and Wintersun White) under three different fertilizer concentrations (112.5, 375 and 675 mg·L^{-1} N) to measure the relationship between chlorophyll concentration (using spectrophotometer) and R_{ratio}. A linear relationship was observed between chlorophyll concentration and R_{ratio} ($r^2 = 0.68$) for all cultivars. Based on these results, it is concluded that R_{ratio} measured using the developed sensor is related to chlorophyll concentration in plants and mostly influenced by differences in tissue N content. Moreover, R_{ratio} can potentially measure tissue N content of whole-plants in several poinsettia varieties.

Genetics & Germplasm 1 (Poster)

Assessment of Genetic Diversity in 91 Cucumber F1 Hybrids Using Genotyping-By-Sequencing Application in Cucumber *(Poster Board #207)*

Junewoo Lee and Younghoon Park*, Pusan National University

A genotyping-by-sequencing (GBS) was conducted for diverse commercial F1 hybrid varieties to identify genome-wide single nucleotide polymorphisms(SNPs) in cucumber(*Cucumis sativus* L.). A total of 91 F1 varieties consisting 9 cultivar groups of Korean, China, Japan, and South Asia were selected for GBS. After reads filtering process, a total of 112,322 SNPs was identified and used for hierarchical clustering, principle component analysis, and population structure analysis of 91 F1 varieties. The results showed that varieties could be divided into 9 major clusters depending on their cultivar group. A subset of non-synonymous 192 SNPs that are evenly distributed in the genome and the polymorphic information content (PIC) values higher than 0.3 was selected for variety identification of 55 F1 hybrids consisting three major Korean cultivar groups(Baekdadagi-gae, Nakhap-gae, and Gasi-gae). The analysis of hierarchical clustering using the subset of 192 SNPs showed all

55 varieties could be distinguished from each other by their unique SNP genotypes. The SNP set developed in this study has potential for application to the SNP-based barcoding for variety identification, F1 seed purity test, and marker-assisted backcross not only in 91 varieties but in diverse resources for cucumber breeding.

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Multivariate Analysis of Seed Phenotype and Biochemical Traits in a Cowpea [*Vigna unguiculata* (L) Walp.] Core Subset *(Poster Board #208)*

John Bradley Morris*; Ming Li Wang and Brandon Tonnis, USDA, ARS, PGRCU

Cowpea [*Vigna unguiculata* (L) Walp.] is used as a vegetable throughout the world and little is known about the variability for protein, seed characteristics, flavonoid, and anthocyanin concentrations. Therefore, 38 cowpea accessions representing a subset of the core collection were subjected to a principal component and cluster analysis. Principal component analysis cumulatively accounted for 27, 46, 62, 74, and 82 % of the variation by adding principal components 1 through 5, respectively. Principal components 1, 2, 3, 4, and 5 were most correlated with anthocyanins, flavonoids, 100 seed weight, seed pattern, and seed pattern color, respectively. Average linkage cluster analysis grouped the original 38 cowpea accessions into well defined phenotypes with five distinct anthocyanin and flavonoid production groups. Groups 1 through 5 represent the highest to lowest producers of anthocyanins and flavonoids by the cowpea accessions. Based on these results, cowpea cultivar development for high biochemical, seed yield, and seed pattern colors for use as new functional and healthier vegetables.

Plant Breeding Coordinating Committee Survey of US Public Plant Breeding Capacity *(Poster Board #209)*

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Plant breeding has been a central part of the Land Grant Mission for more than 150 years. Over the last 25 years there has been a decline in public sector plant breeding efforts. Causes of this erosion are varied, but in order to revitalize, public plant breeding institutions need to describe the features of successful and viable programs across the country. As funding models and markets change, the public sector needs to adapt and defining how capacity has changed is central to the public sector maintaining its social contract and helping to ensure food, nutrition and environmental security into the future.

The Plant Breeding Coordinating Committee (SCC-80) surveyed public plant breeding programs in 2018 to gauge current capacity and understand the challenges public plant breeding faces. Funded by USDA NIFA and NSF PGRP, a standard survey instrument was created and implemented in the NRSP10 database that can be reused every five years to create a time series to understand ongoing changes in capacity and inform US agriculture policy. A total of 287 U.S. public plant breeding programs provided data, representing programs located in 44 states. To complement the survey, NRSP10 hosts a searchable and interactive US map showing participating public plant breeding programs (https://www.nrsp10.org/). Here we present programs registered with the NRSP10, state by state, delineated by crop group and addressing three major categories of selective plant breeding activities: plant breeding research, germplasm enhancement, and variety development.

Specified Source(s) of Funding: USDA NIFA, NSF PGRP

In Vitro Pollen Germination for Interspecific Hybrids (*Camellia oleifera* and *C. grijsii*) of Oil Tea *(Poster Board #210)*

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Oil Tea (*Camellia oleifera* Abel.) is an important woody edible oil plant in China. Oil Tea suffers from low rate of fruit setting in production, which is related to the poor pollination. One of the important influencing pollination factors was pollen germination rate and the rate of pollen tube growth. Using the interspecific hybrids (*C. oleifera* and *C. grijsii*) clone 'Y3' as material, we studied the effects of sucrose, H_3BO_3, $MgSO_4$ and IAA on pollen germination by orthogonal design to determine the best pollen germination medium. The results showed that 'Y3' pollen germination rates were significantly affected by medium components, and the pollen germination rate varied from 29.13% to 56.84%. The pollen germination rate was the highest in the medium T7 (56.84%), which was 44.74% higher than control group (12.10%). The pollen tube length was the longest in the medium T5 (2184.75 µm), while pollen tube length of control group was 608.89 µm. The most of effect of four factors on pollen germination rate and pollen tube growth was $MgSO_4$. The optimal culture medium for promoting pollen tube growth of Oil Tea 'Y3' was: 1% agar, 150 $g{\cdot}L^{-1}$ sucrose, 0.15$g{\cdot}L^{-1}$ H_3BO_3, 0.07 $g{\cdot}L^{-1}$ $MgSO_4$ and 0.01 $g{\cdot}L^{-1}$ IAA. The results of this paper may provide information for foliar application Mg and IAA, which can improve pollen tube growth and fruit setting of Oil Tea in practice.

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Comparison of Agricultural Traits and Physicochemical Properties of Lentil (Lens culinaris Med.), Chickpea (Cicer aretinum L.), and Guar (Cyamopsis tetragonoloba L.) Germplasms Collected from Tropical and Subtropical Regions

(Poster Board #211)

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This study was conducted to investigate the utilization value of legume crops collected in tropical and subtropical areas. We examined agronomic traits to assess domestic adaptability and evaluated useful components of foreign legumes. We used a total of 201 genetic resources of three legumes, conisisting of 68 lentils, 72 chickpeas and 61 guars. The average number of days to flowering of the three leguems ranged from 56.7 to 60.8 days; the shortest in guar and longest in chickpea. The average number of days to growth of the three legumes ranged from the shortest 86.8 days in lentil, to the longest 163.9 days in guar. The maturation period of the three legumes lasted from the end of May until mid-September, based on sowing in March. However, the average yield of lentil was very low, ranging from 0.5g to 30.6g, with an average 16.4g based on 10 plants per accession. The average 100 seed weight of the three legumes was 2.2g for lentil 22.6g for chickpea, and 3.8g for guar. The crude protein content ranged from 14.1% to 32.4% with an average of 20.4%, the highest for guar and the lowest for chickpea. The average crude oil content in the three legume crops was generally low, ranging from 0.8% in lentil, to 4.3% in chickpea(19.3%) and lentil(15.7%). From the agricultural traits analysis, chickpea and guar could grow domestically. However, lentil was difficult to flower and fruit normally during the warmer seasson after May. Therefore, lentil should be considered for late summer cropping during the cool season. The physicochemical properties of the three legumes seem to be useful as they are similar to or better than, thosed of the control common bean.

Genetic Stability of Lily Shoot Tips after Cryopreservation *(Poster Board #212)*

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In this work, shoot tips from adventitious buds induced by tissue cultured bulb-scale segments were successfully cryopreserved by a droplet-vitrification method. The highest rate of shoot formation was obtained from shoot tips treated with LD1 for 60 min and PVS3 for 240 min at 23℃. A total of 160 accessions of lily as well as some Lilium species have been cryopreserved with a mean regeneration percentage of 56.7% after cryostorage. Among Lilium germplasms cryopreserved, there're several Korean, Chinese, and Taiwanese seed stocks which have good qualities for inter-species hybrid. In this study, morphological and genetic stability of regenerated lily plants from shoot tips cryopreserved in liquid nitrogen were also examined. Ten cryopreserved lily germplasm accessions were used to assess morphological and genetic stability. No differences in morphological characteristics including flower, stigma and pollen color, spots on flowers, flower's direction etc. between controls(fresh control and non-cryopreserved) and cryopreserved plantlets. The genetic stability of regenerants (before and after cryopreservation) was investigated using inter simple sequence repeat (ISSR) and AFLP markers. In this study, these results show that droplet-vitrification freezing cryopreservation is a practical method for long-term storage of apple germplasms.

Additional key words: lily, cryopreservation, shoot tip, droplet-vitrification, genetic stability

Characterization of Common and Tartary Buckwheat Germplasm Under Spring Cultivations

(Poster Board #213)

Muhammad Rauf; Yu Mi Choi; Lee Sukyeung; Do Yoon Hyun; Myung Chul Lee; Sejong Oh and Hyemyeong Yoon*, National Institute of Agricultural Sciences

Buckwheat is a gluten-free, functional food crop with high nutritional and medicinal values. It is considered as a short season grain crop that completes its growth cycle quickly within 90 days. In this study, we have evaluate buckwheat germplasm for agronomic traits and compared flavonoid contents in different type of buckwheat. A total of 380 buckwheat germplasm, including 342 accessions of common type and 38 accessions of tartary type, were evaluated for agro-morphological traits. Common type showed higher values of 100-grains weight and total grain weight than tartary type. The percentage of days to 50% flowering at the end of May were 98% in common type and at the early of June were 93% in tartary type. The average flavonoids contents in tartary type tended to be higher than that of common type. The average content of Rutin was 8778.79mg/kg dry weight(DW), and Quercetin was 43.06mg/kg DW in tartary type whereas the average content of Rutin was 220.72mg/kg DW, and Quercetin was 4.51mg/kg DW in common type. In our results, "Kyunbuk-1989-3322" (KOR), "CBU304" (CHN) and "Clfa41" (USA), "CBU261" (KOR) showed the highest values of total grain weight during spring cultivation, respectively. Additionally, three accessions of common type including "Shinshudai soba" (JPN), "Chungbuk-2010-2" (KOR), "Gangwon-2001-21" (KOR) showed higher values (>4g) of 100-grain weight. These identified genotypes could be used as basic genetic resource to improve grain yield in spring cultivation seasons.

Investigations on the Pollen Fertility and Mor-

phology of Three *Camellia* species in China *(Poster Board #214)*

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Pollen morphology characterization is important in taxonomy, conservation and plant breeding, and pollen viability studies can support breeding programs in *Camellia* species. This study investigated pollen fertility and pollen morphology in eight cultivars of *Camellia oleifera*, one *species C. handelii* and *C. gigantocarpa*. The male fertility was examined by in vitro pollen germination, and the morphology of these pollen grains was observed by scanning electron microscope. The results showed that the pollen viability varied from 47.18% to 83.45%. The pollen morphology of three *Camellia* species were ellipsoidal or nearly spherical, and the polar view was trilobate-circular. Three germinal furrows annularly distributed in equal space and presented in all tested *Camellia* pollen grains, which indicated that the pollens belonged to N3P4C3 model. The ten genotypes of pollen grains were largely divided into three groups (*C. oleifera*, *C. handelii* and *C .gigantocarpa*); were mainly the length of polar axis, and the equatorial diameter in morphological characteristics of principal component. The morphological characteristics of pollen grains and pollen fertility could provide important information for cultivar identification and hybrid breeding of these *Camellia* species in the future.

Specified Source(s) of Funding: the Major Scientific and Technological Special Program in Hunan Province (No. 2018NK1030)

QTL Analysis of Seed Coat Deficiency As Related Food-Grade Soybean for Natto *(Poster Board #215)*

Qian Zhu*; Diana M. Escamilla; Luciana Rosso; Nick D Lord and Bo Zhang, Virginia Tech

Natto, a traditional Japanese soyfood, is produced usually using small-seeded soybean (*Glycine max* L.). Seed coat deficiency (SCD) is an undesirable trait for natto production because they cause an inferior appearance of the products and it clogs the production lines. Development of soybean cultivars with decreased SCD is crucial for maintaining and increasing the natto soybean market. However, the understanding of the genetic control of SCD on soybean seeds was very limited. Thus, the objective of this study was to identify and validate quantitative trait loci (QTL) underlying SCD. V12-1626 (SCD, 6.8%) and V11-0883 (SCD, 37.7%) exhibited significant differences in SCD. One mapping population derived from V11-0883 x V12-1626 were grown in Blacksburg, VA in 2016 (240 F_3), 2017 (240 F_5) and 2018 (222 F_6), respectively. One validation population derived from V11-0883 x V12-1885 were grown in Blacksburg, VA in 2016 (155 F_3), 2017 (153 F_5) and 2018 (153 F_6), respectively. Phenotypic data of SCD of each individuals of all populations were collected after 100 unbroken seeds soaking for 10 min in 1% bleach. Mapping population SCD variated from 0 to 91% with a mean of 21.8%. Broad sense heritability of SCD was estimated to be 0.40. A total of 1,318 single nucleotide polymorphism (SNPs) out of 6,000 SNPs tested were polymorphic between parents in the mapping population. Linkage maps consisted of 1258 SNPs on 20 linkage groups with a total length of 1,826 cM and average marker interval of 1.6 cM. One major QTL across three years (*qSCD20_1*) was identified near Gm20_34881595_C_T and Gm20_36651429_T_C on chromosome 20 (LG I) with logarithmic odds score of 8.43, 15.15 and 3.08, accounting for 11.3, 24.3 and 5.6% of the variation of the trait in 2016, 2017 and 2018, respectively. The study of QTL confirmation is still on going, but we expect that the high phenotypic variation explained by *qSCD20_1* will be able to be confirmed using the validation population. Then, the SNP markers identified will be used for marker assisted selection to accelerate the breeding of this trait in natto lines.

Specified Source(s) of Funding: Montague Farms, Inc.

The Inheritance of Multiple Qualitative and Quantitative Character Traits in *Heliopsis Helianthoides* (L.) Sweet *(Poster Board #216)*

David C. Zlesak*, University of Wisconsin, River Falls and Brent Hanson, Hanson's Garden Village

Heliopsis helianthoides (L.) Sweet (aka false sunflower, heliopsis, smooth oxeye, and sunflower heliopsis) is an herbaceous perennial in the Asteraceae native to the prairies of North America. The combination of drought-tolerance, pest resistance, and long bloom season makes heliopsis an attractive choice for perennial gardens. New character traits in heliopsis have been identified and commercialized during the past 20 years and expands the utility of this species. The authors initiated a heliopsis breeding program in the late 1990s and developed a number of populations useful to document the inheritance of: red petal bases, variegated foliage, number of ray florets per inflorescence, ray corolla width, and overall inflorescence diameter. Variegated foliage is a qualitatively inherited trait controlled by a dominant allele at a single locus. Segregation of F_1 hybrids between 'Loraine Sunshine' (first variegated cultivar) with green-leaved selections fit a 1:1 variegated:green ratio, pointing to 'Loraine Sunshine' being heterozygous for the trait. Variegated F_1 offspring were planted in isolation (heliopsis possesses sporophytic self-incompatibility) and their offspring fit a 3:1 variegated:green ratio, further supporting the model. Red petal bases is a qualitatively inherited trait controlled by a recessive allele at a single locus. 'Prairie Sunset' (first red petal based cultivar) was grown in isolation with solid yellow flowered plants and all seedlings of 'Prairie Sunset' were yellow. Segregation in the F_2 generation fit a 3:1 solid yellow:red petal base ratio supporting a single gene recessive allele model. The expression of the intensity of red

pigmentation and how far up the corolla it was expressed was variable between the red petal-based genotypes. Ray floret number per inflorescence, ray corolla width, and overall inflorescence width are quantitatively inherited. Three F_1 populations were used to estimate narrow sense heritability using offspring mid-parent regression. Eight diverse F_1 hybrid selections were allowed to open pollinate and their offspring were raised to estimate narrow sense heritability using offspring parent regression. Narrow sense heritability was moderate to high at 0.64, 0.53, and 0.65 using offspring mid-parent regression and 0.41, 0.58, and 0.54 using offspring parent regression for ray floret number per inflorescence, ray corolla width, and overall inflorescence width, respectively. Understanding the inheritance of key character traits in heliopsis is valuable to help breeders strategically and efficiently combine them in new cultivars.

Field Evaluation of *Solanum Jamesii* – a Native USA Wild Potato *(Poster Board #217)*

John Bamberg[1]; Kevin A. Lombard[*2]; Alfonso Del Rio[3]; Charles Fernandez[3]; Lisbeth Louderback[4]; Bruce Pavlik[5] and David Kinder[6], (1)USDA/ARS - U.S. Potato Genebank, (2)NMSU-ASC, (3)USDA/Agricultural Research Service, US Potato Genebank, (4)Natural History Museum of Utah, University of Utah, (5)Red Butte Garden and Arboretum, University of Utah, (6)Ohio Northern University

One of the two potato relatives native to the USA is *Solanum jamesii* (jam), originating in the Four-Corners states and western Texas. The US Potato genebank has collected and studied over 200 populations since 1958. The species is of interest for research and breeding by virtue of its resistance traits for pests, such as extreme late blight (*Phytophthora infestans*), nematodes and insects. Furthermore, the tubers have long dormancy, freezing tolerance and are exceptionally nutritious, containing high levels of antioxidants that inhibit prostate cancer. Although considered a wild species, it is often associated with ancient native habitation sites, suggesting its natural history may have been influenced by cultivation and transport by humans for over 10,000 years. We grew 130 populations from across the natural range in a cultivated field at the NMSU Agricultural Science Center research farm at Farmington during the 2016 and 2017 seasons. Plants growing in the wild often occupy shady habitats in mulch or among rocks and are usually small and without flowers. Plants at Farmington's irrigated, open field plots in a sandy loam soil, however, exhibited robust growth and flowering, and attracted abundant bumble bee pollinators that encouraged fruit set. This demonstrates that sexual reproduction under ancient human cultivation may have been much more prevalent than previously assumed. Contrary to expectations, little difference in shoot morphology was observed among populations. In contrast to other studies, all populations tuberized readily but with no marked differences in tuber size that could be associated with origin from human habitation sites. All tubers subjected to freezing tests were extremely hardy but with some indication that populations from wild sites are slightly more freeze hardy. This survey of *jam* growing in the Farmington field made it possible to make observations and collect tuber samples for analysis that were relevant to the climate and soil to which this species is naturally adapted, and allowed us to detect subtle effects that can now be tested with more focused studies. The ASC Farmington is also engaged in conventional table and chip cultivar trials of *S. tuberosum* and perhaps ideal breeding traits from *S. jamesii* could be introduced into *S. tuberosum*. Or perhaps the *S. jamesii*, could become a reintroduced component of a culturally appropriate dietary source or, southwestern/Native foodways-branded food.

Specified Source(s) of Funding: USDA/Agricultural Research Service, US Potato Genebank/NMSU Agricultural Experiment Station

Ornamentals/Landscape and Turf (Poster)

UF/Ifas Florida-Friendly Landscaping™ Program's Green Industries Best Management Practices Training Promotes Sustainable Urban Landscapes *(Poster Board #353)*

Tom Wichman*; Esen Momol; Laurie Trenholm; C J Bain and John Bossart, University of Florida

Florida enjoys an abundance of lakes, rivers and coastal waters, many with densely populated urbanized watersheds. Urban landscaping practices, including irrigation, fertilizer and pesticide use, contribute to nonpoint source pollutant loading to surface and ground waters. Landscaping and lawn care are major businesses in Florida, employing tens of thousands of green industry professionals. To help minimize the potential nonpoint source loading from inappropriate landscaping practices, the UF/IFAS Extension Florida-Friendly Landscaping™ Program, in partnership with the Florida Department of Environmental Protection (FDEP), trains thousands of landscaping professionals statewide through the Green Industries Best Management Practices (GI-BMP) Training Program. State of Florida statutes require this training for all landscaping professionals who apply fertilizers. The training program has four main program goals: reducing off-site transport of sediment, nutrients, and pesticides to surface water or groundwater; promoting appropriate site design and plant selection; using appropriate rates and methods for irrigation and fertilizer application; and promoting integrated pest management (IPM) practices. The GI-BMP training includes six learning modules covering efficient use of water and fertilizer, integrated pest management, fertilizer application, and pollution-minimizing lawn and landscape cultural practices. Course delivery is available through several formats, including in-person classes, or self-paced instruction available online or through a DVD. Courses are available in English and Spanish, with Haitian Creole available through in-person classes. Those persons successfully completing the training and a written exam receive formal GI-BMP certification. Since the program's start in 2006 (and through 2018), over 59,364 persons received training, with 50,440 of these trainees receiving their GI-BMP certification. Surveys conducted 6 months after each training class assess the extent to which trainees have changed their landscaping behaviors and practices to conserve water and reduce pollutants. For 2018, these surveys found that, post-training, 93-98% of the attendees use the GI-BMPs on a regular basis, with substantial improvements shown in those who always use the following practices: apply no more than 0.5-0.75 inches (1.27-1.91 cm) water per irrigation event (for water savings of 25-50%); reset irrigation controls/timers seasonally; use less fertilizer; and use integrated pest management. Further, the post-training surveys documented adoption of new technologies, specifically 74% using soil tests to determine fertilizer needs and 76% using soil moisture or other sensing devices to ensure effective water use.

Specified Source(s) of Funding: Florida Department of Environmental Protection and UF/IFAS Extension

Empowering the New Landscape Entrepreneur: Increasing Profitability through Business Training and Professional Certification *(Poster Board #354)*

Bodie V. Pennisi[1]; Greg Huber[1]; Stephen Newton[1]; Ellen Bauske[*1]; Tim Daly[2] and Anne Randle[2], (1)University of Georgia, (2)UGA Extension

The strong economy has fueled construction projects which correlate strongly with new landscape installation. The landscape business has low barriers to entry and is therefore highly attractive to entrepreneurs. Small businesses (4 or less employees) are essential to the economy and given the high failure rate of start-ups, training and certification is essential to improving the chance of success for these entities. Based on queries registered with UGA Extension and the UGA Small Business Development Center (SBDC) in 2016 and 2017, a high number of individuals who have never run a landscape business, or have run one on a part-time basis are interested in entering the landscape business full-time. One of the most challenging areas of business is accurate cost estimating and bidding on landscape projects. Owners (especially new ones) bid either too low and lose money, or they bid too high and lose jobs to competitors. Many landscapers take a guess at pricing using multipliers or standard mark-ups on the cost of materials without fully understanding their expenses and profits; not only is this an unreliable business practice, but it is not sustainable in the long term. A team of collaborators from academic departments, UGA's public outreach units, Cooperative Extension counties, was able to train 46 landscape business operators on the basics of starting a small business. The training included both financial and marketing aspects (e.g. P&L, income statements, sources of funding, quickbooks, marketing on the web and social media), as well as hands-on practical exercises, on site take-off, interpreting landscape plans. Participants were trained in estimating costs of equipment, labor, materials, and overhead for profitable job bidding by using two software packages developed by UGA and specifically designed for cost-estimating landscape installation and landscape maintenance. The trainings generated 276 contacthours. Thirty five percent of the attendees also signed up for an advanced certification program to become Georgia Certified Landscape Professionals.

Landscape Plants in Buddha Temple Gardens of Zhejiang, China *(Poster Board #355)*

Xiaoqing Song, Zhejiang University of Science and Technology and Donglin Zhang[*], University of Georgia

Buddhism was introduced to Zhejiang (China) nearly 1800 years ago in the Eastern Han Dynasty and it played an important part in the Chinese Buddhism history. Plants are the most important components of the buddha landscape architecture around the temples. We systematically examied the characteristics of landscape plants in buddha temple gardens in Zhejiang and classified them into 1) related to Buddhist legends and created a religious atmosphere, such as *Aesculus chinensis, Nelumbo nucifera, Ginkgo biloba, Sapindus saponaria, Podocarpus macrophyllus* etc.; 2) long-lived native plants that resembled significant influence of Buddhism forever, such as *Pinaceae*, *Cinnamomum camphora*, etc.; and 3) aromatic plants, such as *Chimonanthus praecox*, *Gardenia jasminoides*, *Osmanthus fragrans*, symbolized the fragrance and solemnity of the Dharma. Different plants were also carefully selected for the functional zones of the Buddha temples. The leading space area was often planted with pine, bamboo, camphor and other evergreen plants. Simple and spectacular way of planting design was used to create the secluded space for expressing religious emotions among visitors. Plants in the religious activities area were designed symmetrically to highlight the solemn religious environment of the Buddhism. In front of the temple hall building, taller evergreen trees were arranged symmetrically. In the garden area, numbers of the evergreen trees decreased, while the deciduous trees and flowers shrubs increased. Planting design was changed from formal to natural style, such as specimen, grouping and mass planting. The living area was the living space for monks, as well as guest rooms for pilgrims and visitors. Plants were mainly arranged in a natural way. Economic important plants, such as fruit and tea, were also cultivated for consumption in the temple. Plant diversity with small status and Buddhism culture should be increased.

Keywords: Buddhist temple garden, landscape, plant design

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Installation and Evaluation of Pollinator Habi-

tat in Managed Turfgrass Systems in the Piedmont and Sandhills of North Carolina *(Poster Board #356)*

Lauren D. Kilpatrick*, NC State University

Pollination is an invaluable ecosystem service provided by pollinators such as bees, flies, and wasps. However, with the increase of urbanization, there is a decrease in suitable habitat available for pollinator communities. Therefore, it is imperative to investigate the potential for incorporating pollinator-friendly habitat into existing urban green spaces and to understand how turfgrass systems under different management strategies effect pollinator communities. The objective of our research is to 1) install pollinator habitat on out-of-play areas on golf courses as well as homeowner lawns in North Carolina that are subjected to different turfgrass management strategies, and 2) evaluate the biodiversity of the pollinator communities they support.

Twelve turfgrass sites were selected based on location, site suitability for habitat establishment, and management intensity. Initial insect sampling was conducted beginning in the summer of 2018 in order to record a baseline for pollinators found at each site.

In October 2018, sites were seeded with a pollinator-friendly Southeastern wildflower seed mix. Formal sampling for pollinators and floral resources will begin in May, 2019. Preliminary results from this research will be presented at this conference, American Society for Horticulture Science. We anticipate that our findings will support the hypothesis that pollinator communities found in association with managed turfgrass systems are both abundant and biodiverse.

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Perspective of Soil Physical Properties and Cultivation Practices of Golf Course Putting Greens at Oklahoma *(Poster Board #357)*

Naba Amgain* and Charles Fontanier, Oklahoma State University

Managing soil organic matter and rootzone moisture patterns of sand-based putting greens is critical to long-term health of turfgrasses. Soil compaction and accumulation of organic layers near the root zone surface reduce infiltration rates, decrease surface firmness, inhibit deep rooting, and negatively affect playability. Cultivation practices such as hollow-tine core aerification have traditionally be used to maintain desirable rootzone physical properties and reduce organic matter build up but can be overly disruptive to the playing surface. The objective of this study was to characterize the short-term effects of relatively non-invasive cultivation practices on soil physical properties of sand-based golf putting greens. The study was conducted on-site at six golf courses in central Oklahoma that utilized either hollow-tine core aerification, dry sand injection (DryJect), or air injection (Air2G2) cultivation methods. Cultivation events occurred in spring 2017 and 2018. Two putting greens were evaluated at each golf course and three sub-samples were taken per green. Measurements of infiltration rate, volumetric water content, surface firmness, ball roll distance, and sand particle size distribution were conducted prior to a cultivation event and subsequently at 3 days, 1 week, and 4 weeks after the event. Similar measurements were taken seasonally to characterize the typical conditions at each location. The study suggests these novel cultivation practices can be effective tools for golf course superintendents seeking lower disruption to the playing surface, but conventional hollow-tine core aerification still has the largest effect on rootzone properties.

Drought and Recovery Responses of Selected St. Augustinegrass Cultivars *(Poster Board #358)*

Tim Pannkuk* and Ryan Saucier, Sam Houston State University

Landscape water conservation continues to be critical strategy for securing future water demands, especially in locations experiencing frequent droughts. Water users' inability to characterize drought stress related to plant health can result in inappropriate use of water during drought conditions. St. Augustinegrass (SA) [*Stenotaphum secundatum* (Walt.) Kutnze] is a widely used warm-season turfgrass found throughout the southern United States. Data comparing SA cultivar's performance during extended drought stress conditions and recovery is limited, and existing results are from late summer and fall conditions in full sun. Cultivars Delmar, Floratam, Palmetto, Raleigh, and Tamstar were evaluated in a consecutive 60-day drought in spring 2018 in full sun and 50% shade. Following drought, turf were evaluated during a 60-day recovery period. Using a rating system, drought response and recovery will be quantified every 7-10 days as turfgrass quality (1-9; 9=best). All cultivars in 50% shade treatment, except Tamstar, were in acceptable condition (>6.0) at the end of 60 day drought in 2018. Imposition of drought and recovery from drought are evaluated again in spring/summer 2019. Results may have significant impact on both turfgrass cultivar recommendations and landscape irrigation behaviors.

Specified Source(s) of Funding: Sam Houston State University

Stimulating Stress Tolerance in River Birch *(Poster Board #359)*

Lloyd L. Nackley*, Oregon State University and Drew Zwart, R.A. Bartlett Tree Research Labs

River Birch (*Betula nigra*) is one of the more popular shade trees planted in landscapes across USDA Zones 4-9 the United States. River birch is marketed as the most borer resistant birch, tolerant of both wet and dry summers.

Yet, landscape managers in western states regularly report drought-stress symptoms including tip die-back, leaf-scorch and ultimately plant death. Stressed trees are often more susceptible to insect attack. Trees in residential landscapes are often experience sudden and drastic changes to growing conditions when lawns are removed, irrigation is altered, hardscapes are installed, or the landscape topography is changed. Biostimulants are a group of organic substances marketed to provide "benefits" including increasing plant tolerance to and recovery from abiotic stresses. However, at this time there is not a legal definition for biostimulants in the United States, which engenders a skepticism about the validity of the benefit from these products. To investigate the effect of these emerging products we established an experiment to learn if selected biostimulants would improve the drought tolerance of river birch. Our test was conducted in a wind-screened can-yard, at Oregon State University, North Willamette Research and Extension Center, in Aurora Oregon. We transplanted 72 bareroot whips into #5 black plastic nursery containers (19 L volume) filled with 100% Douglas-fir amended bark media. The 72 potted trees were dispersed in a completely randomized one-way factorial design. In total, we had six treatment groups (n =12). Treatment groups included one group that was not subjected to drought-stress. All other trees were subjected to drought conditions: four groups treated with different biostimulants, and one untreated drought group. Plants were evaluated for growth, aesthetics, and leaf-chlorophyll fluorescence. The results showed significant differences ($p < 0.05$) between the treatment groups, suggesting that certain biostimulants may mitigate the harmful effects of drought stress more than others.

Shade-Loving *Sarcococca*plants for Your Landscape and Gardens *(Poster Board #360)*

Jordan Baylor; Connor Ryan and Donglin Zhang*, University of Georgia

Sarcococca Lindl. isa genus of small to medium evergreen broadleaf shrubs in Buxaceae and has valuable landscape characteristics including fragrant winter flowers, few pests and diseases, and shade adaptability. Despite its desirable features, it is an underutilized plant in the landscape. To increase its popularity, we employed flow cytometry and ISSR molecular markers to clarify the taxonomic confusion and taxon delineation. From 38 *Sarcococca*accessions collected in US, almost half of them were unidentified or mislabeled. Both genomic data and ISSR markers provided baseline information for breeders, horticulturists, and gardeners interested in improving and utilizing *Sarcococca*plants. With severe damage to members of the boxwood family from new pathogen boxwood blight, we were able to find a few *Sarcococca*taxa with resistance and conclude that all *Sarcococca*taxa were less susceptible to the disease than boxwood controls using detached leaf and detached stem assays. The genus originated in Southeast Asia and adapted well to a variety of soil and water conditions in US. The plant should be planted in partial shade to shade and could be used successfully in both formal and informal landscapes. *Sarcococca* is a slow-grower that preforms great as a groundcover, spreading by rhizomes to fill in gaps. From our research experimenting with different light conditions, we should be able to determine the ideal shade requirements for *Sarcococca*. We are also working on breeding and selecting new *Sarcococca* cultivarsthat should offer better appearance plants to our landscapes and gardens.

Specified Source(s) of Funding: Grants from University of Georgia Research Foundation and Georgia Seed Development Commission.

Relative Salt Tolerance of Four Perennial Ornamentals for Sustainable Landscaping with Low Quality Saline Irrigation Water *(Poster Board #361)*

Triston Hooks*, Texas A&M AgriLife Research, Texas A&M University

Relative salt tolerance of four perennial ornamentals for sustainable landscaping with low quality saline irrigation water

Triston Hooks[1] and Genhua Niu[1]

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Abstract

Salt tolerant ornamental plants can be irrigated with low quality saline irrigation water for sustainable landscaping in arid and semi-arid regions. However, little attention has been devoted to evaluating salt tolerance in ornamentals. An eight-week greenhouse experiment was conducted to assess the relative salt tolerance of four perennial ornamentals, 'Angelina' (*Sedum rupestre*), 'Autumn Joy' (*S. telephium*), 'Blue Spruce' (*S. reflexum*), and 'Blue Daze' (*Evolvulus glomeratus*). The plants were grown in pots with potting mix substrate and irrigated with control or saline solutions. The electrical conductivity (EC) of the saline solutions were 5.0 and 10.0 mS/cm. Data collected included relative shoot, root, and total dry weight (DW), visual score, shoot tissue concentrations of Na^+, Cl^-, K^+, and Ca^{2+}, and the K^+/Na^+ ratio. There were significant differences in treatment and varieties for all response variables, and some interactions were also significant indicating different responses to salinity from the four varieties. Shoot, root, and total DW decreased with increasing salinity for all varieties and shoot growth appeared to be more sensitive to root growth only in Angelina and Blue Daze when treated with EC5. Visual score was highest in Autumn Joy and Blue Spruce when treated with EC5 and EC10 and lowest in Angelina and Blue Daze, the latter of which showed symptoms of moderate foliar damage including leaf necrosis, or "burn", due to salt. The concentrations of Na^+ and Cl^- in the shoot tissue increased with increasing salinity

while K^+ and Ca^{2+} and the K^+/Na^+ ratio tended to decrease. Autumn Joy had the lowest concentrations of Na^+ in the shoot tissue and the highest K^+/Na^+ ratio. Blue Daze had the lowest concentrations of Cl^-, K^+, and Ca^{2+} and the lowest K^+/Na^+ ratio. Of the four varieties of ornamental plants evaluated in this study, Autumn Joy and Blue Spruce were considered the most relatively salt tolerant while Angelina and Blue Daze were considered less tolerant.

Acknowledgments

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Specified Source(s) of Funding: Floriculture and Nursery Research Initiative

Effects of Melatonin and AVG in Alleviating Dark-Induced Plant Deterioration of Three *Pilea* Species *(Poster Board #362)*

Chi Dinh Nguyen*, University of Florida/IFAS; Diying Xiang, Mid- Florida Research and Education Center and Heqiang Huo, University of Florida

Ornamental foliage plants are valued for their exquisite leaves with diverse shapes and colors, yet dark-induced plant senescence or deterioration during transport greatly impacts the quality of foliage plants. Melatonin is an important signaling molecule that affects pleiotropic developmental progresses in plants, and 2-aminoethoxyvinyl glycine (AVG) is a potent inhibitor of ethylene biosynthesis and extensively used for delaying plant senescence and fruit ripening. In this study, we compared the effects of melatonin and AVG in alleviating plant deterioration of three *Pilea* species (*P. cadierei* (PC), *P. involucrata* (PI) and *P. mollis* (PM)) through foliar sprays of different concentrations of melatonin or AVG prior to dark treatment. Our results showed that PC, PI and PM exhibited distinct responses to melatonin or AVG. PM is the most sensitive species that exhibited significant increases in stem height, leaf area, chlorophyll and anthocyanin content in responses to 50, 100 and 150 $\mu mol \cdot L^{-1}$ of melatonin; similar responses to 150 and 200 $\mu mol \cdot L^{-1}$ of melatonin were observed in PI with regard to these plant characteristics. By contrast, much less effects of AVG on these plant characteristics were observed in PM and PI, although it increased their Fv/Fm values as with melatonin. Unlike PM and PI, PC is generally not responsive to all melatonin and AVG treatments, despite AVG treatments could alter stem elongation. The results may provide growers science-based information for future practical application of melatonin to maintain the quality of ornamental plants during and after transportation.

Relative Salt Tolerance of Eight Woody Ornamentals *(Poster Board #363)*

Genhua Niu*, Texas A&M AgriLife Research Center at El Paso, Texas A&M University and Triston Hooks, Texas A&M AgriLife Research, Texas A&M University

A greenhouse study was conducted to assess the relative salt tolerance of eight woody ornamentals: *Itea virginica* 'Scentlandia', *Juniperus communis* 'Gold Cone', *Loropetalum chinense* 'Jazz Hands Bold', *Aronia melanocarpa* 'Low Scape Hedger', *xPyracomeles* 'Juke Box', *Ilex glabra* 'Shamrock', *I. verticillata* 'Berry Poppins', and *I. x meserveae* 'Castle Spire'. Rooted cuttings received from a commercial company were transplanted to 2.6 L containers filled with Metro-mix and grown in the greenhouse for one month. Plants were then irrigated with nutrient solution at electrical conductivity (EC) of 1.5 dS/m or nutrient-solution based saline solution at EC of 4.0 dS/m (EC 4) or 8.0 dS/m (EC). Four weeks after saline solution treatment, the visual score of plants in EC 8 was the highest in *I. glabra* 'Shamrock', followed by *I. x meserveae* 'Castle Spire' and *J. communis* 'Gold Cone', while *L. chinense* 'Jazz Hands Bold' and *A. melanocarpa* 'Low Scape Hedger' had the lowest scores with severe foliar salt damage. Plants in EC 4 had minimum foliar damage except for 'Jazz Hands Bold', *A. melanocarpa* 'Low Scape Hedger', and *xPyracomeles* 'Juke Box'. Based on leaf area and dry weight, salinity treatment did not impact the *I. glabra* 'Shamrock', *I. x meserveae* 'Castle Spire', and *J. communis* 'Gold Cone'. The growth of *I. verticillata* 'Berry Poppins' was only reduced in the EC 8 treatment. In summary, among the eight species, *I. glabra* 'Shamrock', *I. x meserveae* 'Castle Spire', and *J. communis* 'Gold Cone' were relatively tolerant to elevated salinity, while *L. chinense* 'Jazz Hands Bold,' *A. melanocarpa* 'Low Scape Hedger', and x*Pyracomeles* 'Juke Box' were less tolerant.

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Survival of Four Native Hawaiian *Peperomia* species Under Three Indoor Light Conditions *(Poster Board #364)*

Orville C. Baldos* and Aleta K. Corpuz, University of Hawaii at Manoa

The use and promotion of native plants as ornamentals in Hawaii has increased in the last 30 years due to issues concerning invasive species and the importance of conserving biodiversity. While some success has been achieved in promoting native species for landscaping, limited research has been done to identify species for indoor use. Among all the native species found in the Hawaiian Islands, species in the genus *Peperomia*, possess the most potential as indoor plants. To evaluate the potential indoor use of Hawaiian *Peperomia*, we conducted a study to determine survival of four species (*P. cookiana, P. leptostachya, P. oahuensis* and *P. sandwicensis*) under three indoor light levels. Shade house grown plants of each species were transferred indoors (23.12 °C and 54.79% RH) and grown for six months under three different light levels: 1) next to a north facing window (2.35 $mol \cdot m^{-2} \cdot d^{-1}$); 2) under a 12-hour fluorescent light treatment mimicking regular office conditions (0.43 mol·m-

$^{2}\cdot d^{-1}$); and 3) under a 12-hour low fluorescent light treatment (0.22 mol·m$^{-2}\cdot$d^{-1}). Ten plants per species were grown in each light treatment. Daily plant mortality was recorded for six months. Results indicate that *P. sandwicensis* was the most tolerant species under the three light conditions. Under low light conditions, *P. sandwicensis* was the only species that survived (60% survival). Survival of *P. sandwicensis* under office light condition and window light condition were 100% and 80%, respectively. *P. blanda* survival was high under window light conditions (80%), but not under office and low light conditions (<30%). This study indicates the potential for developing *P. sandwicensis* and *P. blanda* as indoor plants.

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Does Salt Composition Affect the Results of Relative Salt Tolerance? *(Poster Board #365)*

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Different salts have been used for evaluating relative salt tolerance of crops**.** A greenhouse study was conducted to assess the effects of different salt compositions on the growth and visual quality of six herbaceous perennial ornamentals: 'Angelina' (*Sedum rupestre*), 'Autumn Joy' (*S. telephium*), 'Blue Daze' (*Evolvulus glomeratus*), 'Blue Spruce' (*S. reflexum*), 'Indian Summer' (*Rudbeckia hirta*), and 'Sunny Border' (*Veronica longoflia*). A total of four treatments were used, including a control nutrient solution prepared with reverse osmosis (RO) water and fertilizer (15-5-15) at a rate of 200 ppm N. The control nutrient solution was also used to prepare the three different saline solutions, which were: NaCl, NaCl + $CaCl_2$ (2:1 molar ratio), and NaCl + $CaCl_2$ + $MgSO_4$ (87%, 8%, and 5%, respectively). All three saline solutions were prepared at an equal electrical conductivity (EC) of 7.0 mS/cm. Rooted cuttings of the six species were received from a commercial company and transplanted to 2.6 L containers with potting mix. Following establishment, treatments were applied for a duration of eight weeks and weekly visual score and leachate data were collected, along with shoot and root tissue dry weight (DW) following termination of the study. Results showed a trend of reduction in all response variables in plants treated with saline solutions, regardless of the composition. For visual score, only one species, 'Indian Summer' (*R. hirta)*, showed more sensitivity to NaCl than the other salt compositions. For the relative growth (DW of shoots, roots, total), no differences among salt compositions were observed, regardless of species. Interestingly, 'Autumn Joy' (*S. telephium*) and 'Blue Spruce' (*S. reflexum*) maintained excellent visual quality throughout the experiment, regardless of the salt composition, indicating that these two species were relatively salt tolerant. In conclusion, salt composition did not appear to affect the evaluation of relative salt tolerance of the six herbaceous perennial ornamentals tested in study.

Specified Source(s) of Funding: USDA ARS Floriculture and Nursery Research Initiative (FNRI)

Evaluation of Single and Four-Node Stem Cuttings As a Propagation Material for Six Accessions of Pa'uohi'iaka *(Jacquemontia sandwicensis)* *(Poster Board #366)*

Orville C. Baldos*, University of Hawaii at Manoa and Darel Antesco, University of the Philippines Los Banos

In Hawaii, the use of native plants as ornamentals has increased in the last 30 years due to state legislation promoting its use in state-funded landscaping projects. Despite the increase in the use of native plants in urban areas, the availability and variety of horticultural selections still continue to be limited. Pa'uohi'iaka (*Jacquemontia sandwicensis*) (Convolvulaceae) is an endemic coastal plant that has been used as a groundcover in landscaping. In the wild, morphological variations in Pa'uohi'iaka exist, making it a potential species for developing new selections. Due to its pre-formed roots, the plant is relatively easy to propagate. Three to four node stem cuttings is often recommended for its propagation. However, the use of single-node stem cuttings might be useful for propagating more plants with less planting material. This study aimed to characterize the rooting response of the six Pa'uohi'iaka accessions and to determine the feasibility of propagating from single-node stem cuttings. Four-node and one-node stem cuttings from each accession were prepared and planted in pots filled with a 1:1 perlite and vermiculite mix. Each treatment had ten stem cuttings per pot and was laid out as a split-split-split plot experiment replicated four times. The season of propagation served as the main plot, accessions served as the split-plot and the number of nodes served as the split-split plot. Stem cuttings were allowed to root under mist irrigation set to open for ten seconds every six minutes. Root length, root number, percent rooting, number of shoots and number of leaves retained were measured 21 days after planting. Results indicate that, in general, four-node stem cuttings have a significantly higher number of roots and percent rooting compared single-node cuttings. In both four-node and single-node cuttings, Ahihi-Kinau exhibited the highest number of roots and shoots among the six accessions. The use of single node stem cuttings was feasible only to Ahihi-Kinau and Shidler College accessions. Glabrous leaf accessions (Ahihi-Kinau, Shidler College and Lyon Arboretum) exhibited a significantly higher number of leaves retained leading to favorable rooting response. Pubescent leaf accessions (McGregor, Puhala Bay and South Point) had poor leaf retention and rooting. The experiments indicate that the presence and type of leaves, as well as stem cutting length, are crucial in successful rooting of Pa'uohi'iaka.

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Water Conservation for Irrigation of Urban Ornamental Plants in Hong Kong *(Poster Board #367)*

Chung Sang Luk*, Technological and Higher Education Institute of Hong Kong

As the fresh water is also limited in Hong Kong, the Hong Kong government tried to solve the problem. In the 1960s when the Hong Kong government began to import raw water from Dongjiang (the East River) from neighboring Guangdong province. Currently, around 70-80% of our fresh water comes directly from Dongjiang. According to the government record in 2017, the costing of import raw water from Dongjiang is 14. 4 billion Hong Kong dollars per 3 year (~4.4 billion Hong Kong dollars per year).

This project aims to study water conservation for irrigation of urban ornamental plants in Hong Kong. Nearly all the horticulture and landscape maintenance contracts in Hong Kong are mentioned that the plants should be daily watering with 100mm to 150mm deep. According to LCSD, the landscape area is over 1.5 million m^2 that is a large amount of water consumption (270 billion liters of water per year). If the watering has to be done bi-daily, it can satisfied the daily water consumption of 1.25 million families in Hong Kong. The value of the water is around 1.1 billion Hong Kong dollars per year.

In the experiments, the drought resistance of plant was investigated of the 12 species (*Celosia argentea* var. plumose, *Duranta iorentzii*, *Arachis hypogaea*, *Lantana camara, Hibiscus rosa-sinensis*, *Liriope spicata, Ophiopogon japonicus* cv.'Nanus' and *Sphagneticola trilobata*, *Zoysia japonica, Axonopus compressus*, *Schefflera arboricola* 'Variegata' and *Rhoeospathaceo* cv. Compacta) which were urban ornamental plants in Hong Kong. During the experiment, the lifespan of those species under drought were collected (Fig. 4.6). The five species of *Celosia argentea* var. plumose, *Duranta iorentzii*, *Arachis hypogaea*, *Lantana camara and Hibiscus rosa-sinensis* had the shortest lifespan. They could not live over 6 days under the drought. The three species of *Liriope spicata*, *Ophiopogon japonicus* cv.'Nanus' and *Sphagneticola trilobata* could not live over 32 days under the drought. The two species of *Zoysia japonica and Axonopus compressus* could not live over 36 days under the drought environmental condition. Only the two species of *Schefflera arboricola* 'Variegata' and *Rhoeospathaceo* cv. Compacta had the longest lifespan. They could live over 2 months (80 days and 81 days) under the drought environmental condition.

The result in experiment 2, it proved the lifespan under drought environment can be affected by the soil volume and planting density. The result in experiment 3, the species in the two trials were longer than the estimated days from experiment 1. As the reason of the variety of plant habits, the trials with planting different species should extend their life under drought environmental condition.

In the part of questionnaire, it has contacted respondents by on-line questionnaire method, who worked in the related industry. There were altogether 77 persons who had completed the designed questionnaires. Basic information, opinion on watering plants as well as recommendations and suggestion were obtained from them. Those information, opinions and recommendations on the practice of plant watering were used to support the recommendation.

To conclude, the drought resistance of plant had the relationship with the origin of species, soil volume, planting density and variety of plant habits. After summarizing the results, the recommendations was covered the garden design, horticulture maintenance contract specification, front-line staff training and new technology. All the results were used to further prove the corn problem in some real case study.

Public Horticulture (Poster)

Technique for Moss Establishment on Rock Surfaces *(Poster Board #025)*

Matthew D. Taylor*; Ashley Clayton and Rylan Date, Longwood Gardens

In 1931, the Main Fountain Garden opened at Longwood Gardens in Kennett Square, PA. After 83 years in operation, the centerpiece garden at Longwood underwent a massive revitalization. This project included the construction of a Grotto created with local Avondale Brownstone and was to feature a rock wall with ferns and mosses growing amongst the large stones. The Grotto would be a low light, damp, man-made environment with supplemental LED lighting. The objective of this work was to determine a method to grow moss on the rocks of the Grotto wall prior to the structure being complete. To mimic the suspected environmental conditions in the Grotto, moss trials were conducted in a basement under LED lights comprised of 80% red and 20% blue light. The lights were kept on 24-hours a day and light levels were 15 $\mu mol \cdot m^{-2} \cdot s^{-1}$. A preliminary trial developed a general recipe for a soil that would adhere to the rock face and provide a substrate for moss growth. The recipe was a 2:3 ratio by volume of Elmer's Glue-All™ : Water, followed by mixing in potting media until a paste consistency was formed. The experiment tested two types of the sticky soil (created with SunGro propagation mix or pure peatmoss) with seven moss samples (5 different species) collected across Longwood Gardens property and with stone lying flat or at a 45-degree angle. Treatments were applied to same Avondale Brownstone used for Grotto construction. For each treatment, stick soil was applied at a thickness of 0.3 cm and at an area the size of each single piece of intact harvested moss (ranging from 6 to 26 cm^2). Moss was watered 3 days a week and growth was measured 24 and 58 days after transplanting. The majority of moss species exhibited no growth over the course of the experiment regardless of angle or substrate. When comparing peat and propagation mix, more moss species grew on peat based sticky soil. The largest and most consistent growth occurred with *Orthodicranum viride* that showed positive grown with all treatments. Positive growth only occurred with two of the remaining 20 treatments. Based on the results *Orthodicranum viride* and one of the three *Hedwigiaceae* were recommended for use in the grotto. Both have successfully established and grown on the rocks.

Fruit Bagging: A Small-Grower and Consumer Horticultural Practice across the U.S. *(Poster Board #026)*

Ann Katherine Kule* and Juan Carlos Melgar, Clemson University

Fruit bagging is a simple method used to protect fruit from pests and diseases. It is very popular among backyard gardeners in Asia and there is an increasing interest in the U.S. As a consequence of a peach bagging project at Clemson University, over three hundred individual consumers have purchased fruit bags from Clemson University for their own fruit crops. The goal of this research was to survey small growers and backyard gardeners across the U.S. to find out how they implemented the bags into their farming/gardening. A survey was performed online that consisted of five specific questions regarding the type of crop that was bagged, application of chemical sprays on the fruit crop, the state each individual was located in, their success rate, and overall happiness with the fruit quality. There was a thirty-five percent response rate. Results showed that most consumers used the bags on peaches, although other fruits such as apples, pears, grapes and tomatoes were also bagged. A high percentage did not spray any fungicide or insecticide (synthetic or organic) on their fruit before placing the bags due to concerns about pesticides. Twenty-eight percent reported a 75-100% success rate, with particularly high rates being in warm, dry climates. Forty-two percent reported their success rate from 0-25%. Many commented that this was because they lost their 2018 crop due to weather conditions.

Root Growth & Rhizosphere Dynamics (Poster)

Seed & Stand Establishment (Poster)

Seed Coating Delivery System for Vermicompost and Soy Flour: Biostimulants to Enhance Plant Growth *(Poster Board #132)*

Masoume Amirkhani*[1]; Hilary Mayton[2]; Anil Netravali[3] and Alan Taylor[3], (1)Postdoctoral Research Associate, Cornell University, (2)Cornell University, (3)Professor at Cornell University

Biostimulants, broadly defined, are a diverse range of materials which when applied to plants, seeds, and growing substrates in small quantities, have the capacity to enhance physiological processes in plants that provides potential benefits to growth, development, or stress response. As such, biostimulants have enormous potential to enhance the sustainability of crop production systems. Previous research has shown that the use of substances and microorganisms classified as biostimulants and when applied as seed treatments were able to increase the quality and nutrient efficiency of diverse crops. In this study, micronized vermicompost (MVC), a nutrient rich medium, and soy flour (SF), a plant-derived protein were applied in various combinations as a dry coating blend. Treated broccoli (*Brassica oleracea* L.) seeds were placed in a controlled environment germinator at 20/30° C with a dark/light cycle of 16/8 hours, respectively. Total germination, germination rate and uniformity, seedling fresh and dry weight, total shoot and root length were recorded. In addition, seedling vigor index (SVI) was calculated for each treatment. Percent total germination, germination rate and uniformity for the seed treatments were not significantly different than the non-treated seeds. All seed treatments enhanced plant growth compared to the non-treated controls. Additionally, higher shoot and root length were observed in seed treatments of MVC and SF combined compared to applications of SF treatment alone. Seedling vigor indexmeasured from the MVC and SF blended seed treatment was also significantly higher compared to all other treatments. Greenhouse data also supported laboratory data that the MVC + SF seed coating enhanced plant growth. Collectively, these data show that seed coating can serve as a delivery system for application of biostimulants to enhance plant growth. Keywords: Soy flour, Vermicompost,-Seed treatment, Sustainable agriculture

Specified Source(s) of Funding: Multistate Project W-3168

Innovative Seed Coating to Enhance Cover Crop Seed Germination and Seedling Growth Using Red Clover *(Poster Board #133)*

Yi Qiu*, Visiting Fellow at Cornell University; Masoume Amirkhani, Postdoctoral Research Associate, Cornell University; Zhi Chen, Inner Mongolia Agricultural University and Alan Taylor, Professor at Cornell University

The benefits of cover cropping in both organic and conventional managed systems include improving soil organic matter, soil structure and nutrient cycling, and reducing soil erosion. Red clover, *Trifolium pratense*is widely used as a forage and also as a cover crop in the Northeast, US. Interseeding cover crops may be sown several weeks or months after the main crop is planted. Seed coating technologies incorporating nutritional materials and biostimulants may enhance germination and seedling growth. The current study aimed to develop novel seed coatings formulation using biostimulant components to accelerate the germination of seeds, increase the germination rate and uniformity and enhance early seeding establishment. Red clover seeds were coated with different combinations of soy flour that served as a biostimulant and binder, with diatomaceous earth, micronized vermicompost, and concentrated vermicompost extractapplied as a seed coating blend. Coating experiments were conducted by increasing the proportion of soy flour in the blend from 30-60% by weight. Allcoatings were applied with rotary pan seed coater with 30% build-up by the seed weight. The surface mechanical properties of coated seeds are important indexes to evaluate the quality of coated seeds. The first method used a mechanical shaker (Ro-Tap) to test the integrity of coated seeds. The second method used a texture analyzer (TA.TX-Plus) to measure compressive strength of coated seeds. The third method was a hydration test by soaking coated seeds till they disintegrated. Increasing the proportion of soy flour in the coating blend increased the integrity and compressive strength of coatings, and the time for coatings to disintegrate. The seed coating treatments and non-coated seeds were planted in roll towels in a germinator at 20° C with a photoperiod of 16/8 hours. The results show that coated treatments had a significantly improved germination rate and uniformity with no reduction in total germination compared to the nontreated control. Shoot length, seedling uniformity, seedling vigor index, and dry weight of seedlings of all coated seed treatments were also significantly higher compare to control. Coating technology can be an effective strategy to maximize early stand establishment of cover crops. Keywords: Red clover, Seed treatment, Cover crops, Interseeding

Specified Source(s) of Funding: NIFA, USDA, Federal Capacity Hatch Funds, under Accession #1017599

Floral Visitors of *Helianthus Verticillatus*, a Rare Sunflower Species in the Southeastern United States *(Poster Board #134)*

Nicolas C. Strange*, University of Tennessee

Floral visitors of *Helianthus verticillatus*, a rare sunflower species in the southeastern United States

1. C. Strange[1], E.C. Bernard[1], J.K. Moulton[1], W.E. Klingeman[2], R. N. Trigiano[1]

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Whorled sunflower (*Helianthus verticillatus*) is an endangered species of aster found exclusively in the southeastern United States. Evidence suggests that this species is self-incompatible and reliant on insect pollination for seed production. However, little is known about the general biology of this species, including the identity of probable pollinators. Floral visitors were collected and identified during September of 2017 and 2018. A total of 41 species of visitors (29 Hymenoptera, 6 Diptera, 1 Lepidoptera, and 5 miscellaneous) were trapped during eight collection days at one site in Georgia and two in Tennessee. Within a collection day (7:45 to 18:15), there were either 5 or 6 discrete half-hour time periods when insects were trapped. Insect visitor activity peaked during the 11:45-12:15 and 13:45-14:15 collection periods and was least during the 7:45- 8:45 and 9:45-10:15 periods at all three locations. Visitors were identified to genus and species using morphological keys and some with sequences of the *COX-1* mitochondrial gene. Simpson's Diversity Index was used to assess species diversity within and across each location. The most common visitor across all locations was *Bombus* spp. (bumblebees), followed by *Ceratina calcarata* (a carpenter bee) and members of the halictid bee tribe Augochlorini at the two Tennessee locations. Pollen on visitors was identified to genus via direct PCR of DNA using *Helianthus*-specific microsatellites. Pollen grain counts were obtained from the 10 most common visitors and *Apis mellifera* (honey bee) using a hemocytometer. Of these visitors, *Bombus* spp., *Halictus ligatus* (a sweat bee), and *Melissodes* spp. (long-horned bees) carried the most *Helianthus* pollen grains. These visitors are likely to be the primary pollinators of *H. verticillatus* flowers.

Specified Source(s) of Funding: USDA

Tropical Horticultural Crops (Poster)

Effects of Covering on Production of Pineapple Fruits in Cold Season in Taiwan *(Poster Board #135)*

Jou-Yi Lee*; Ching-Shan Kuan and Chia-Hui Tang, Department of Horticulture, Chiayi Agricultural Experiment Station

Pineapple (*Ananas comosus* (L.) Merr.) is a popular tropical fruit in Taiwan where the climate includes tropical and subtropical zones. Adjusting cultivation practices make it possible to grow high quality pineapples year-round in Taiwan. Covering protection, a practice of shadowing fruits from climate changes, is an ideal method to avoid sunburn and cold damage, as micro-environmental conditions highly affect fruit appearance and quality. In this study, we examined three treatments for fruit protection by using polyethylene film to cover the entire plant, on top of the bush for the fruit itself, or with secondary protection of paper bag on fruit under the film. In the winter, fruits were mature the earliest when entire plants were covered with film. When only the fruits were covered with the film, inter fruitlet cracking numbers were 9.3±3.6, and total soluble solids were 13.6±0.4°Brix. However, covering the entire plant with film to the ground led to higher inter fruitlet cracking numbers 20.3±5.9 and pineapples exhibited sunburn injury as the resulting temperature of fruit shoulder was 20°C higher than the environmental temperature. In early spring, total soluble solids reached 15.4±0.7°Brix, and titratable acidity was

0.52% for fruits covered with both film and paper bag, as the paper bag provided secondary protection. Spring fruits were the heaviest and had the best appearance with secondary protection, and also this treatment enhanced fruit quality with higher total soluble solids. Proper air circulation under the film ideally provides thermal insulation and also keeps sunburn degree low. In sum, our study highlights the importance of understanding micro-environmental conditions for growing pineapple.

Specified Source(s) of Funding: Taiwan Agricultural Research Institute

Cultivar/Accession Trials for Weevil Resistance in Sweetpotatoes Grown in Hawaiʻi *(Poster Board #136)*

James E. Keach*, University of Hawaiʻi at Mānoa and Susan C. Miyasaka, University of Hawaii at Manoa

In recent years damage by both sweetpotato weevil (*Cylas formicarius*) and the newly introduced rough sweetpotato weevil (*Blosyrus asellus*) has negatively impacted the quality of sweetpotatoes (*Ipomoea batatas* ssp. *batatas*) grown for the Hawaiian export market. Demand for the purple-fleshed, white-skinned 'Okinawan' cultivar, which performs particularly well in Hawaiʻi, has increased due to public interest in its antioxidant potential and coverage from popular celebrities. While this cultivar is well-adapted to Hawaiian conditions it is susceptible to rough weevil damage, which makes the tuberous roots visually unappealing. It appears to have some resistance to sweetpotato weevil damage, perhaps through the location of storage roots deep into the soil, but still suffers noticeable damage and the damaged tuberous roots become inedible. We conducted a replicated trial of 10 cultivars/accessions which were previously reported to possess weevil resistance, as well as 'Okinawan' as a control. Significant differences existed among cultivars/accessions for damage from both regular and rough sweetpotato weevils, as well as for other agronomic and culinary characteristics. A second trial encompassing 18 cultivars/accessions, including the best performers from the first trial, is currently underway. These trials experienced outbreaks of sweetpotato scab (*Elsinoë batatas*) and leaf miners (*Bedellia somnulentella*), with the cultivars/accessions showing a range of responses to these cultivation challenges as well. Promising cultivars/accessions are being used to develop a breeding program that incorporates the identified resistance and other traits into an 'Okinawan' background.

Specified Source(s) of Funding: County of Hawaiʻi Dept. of Research & Development, Hawaiʻi Department of Agriculture, Hatch: HAW08043-H

After Harvest Evaluation of Black Spot and Decay on the Fruit of Different Pomegranate Genotypes Grown in a Local Orchard in Florida *(Poster Board #137)*

Shirin Shahkoomahally Shahkoomahally*, University of Florida and Ali Sarkhosh, Univeristy of Florida

Black spot caused by the fungus *Colletotrichum*(anthracnose) and *Botryosphaeria*is the most devastating diseases in fruits and vegetables grown in the tropical climate. Both pathogens infect the fruit in the field while they are immature. Symptoms also appear on the fruit after ripening, causing damage to the fruit during storage, transit, and marketing. The intention of this study was to evaluate the fruit of thirteen pomegranate genotypes; 'Ever Sweet', 'Girkanet', 'Angel Red', 'Ariana', 'Vietnam', 'EG', 'Kara Bala Mi Ursal', 'Molla Nepes', 'Sweet', 'Parfianka', 'Mack Glass', 'Red Silk', and 'Vkusnyi' against black spot and decay. Fruit of the genotypes was harvested and delivered to the University of Florida by a local grower. All genotypes grown in the same orchard under a similar cultural practice. Fruits were stored at 6 C with 92± 3% relative humidity (RH) for 3 weeks in cold storage. Then fruit blackspot, stem end rot, crown rot, and fungal decay were assessed. The results indicated that 'Ariana' (38.75 %) and 'Angel Red' (63.63%) had the highest percentage of blackspot while there was no symptoms of black spot on 'Parfianka' cultivar. Observations on the crown and stem end rot showed that there were no rot in 'Mack Glass', 'Ever Sweet', 'Vietnam', and 'Kara Bala Mi Ursal' cultivars. However, 'Parfianka' and 'Molla Nepes' had the highest percentage of blossom end and husk rot, respectively. Furthermore, even though the fungal severity decay were high in 'Red Silk' (10%). In this study, no decay were observed for 'Mack Glass','Ever Sweet',and 'Kara Bala Mi Ursal'.

Keywords: Crown rot, Fungi, Pomegranate cultivar, Quality, Storage

Vegetable Crops Management 1 (Poster)

Influence of Four Different Mulching Materials on Yield and Quality of Cucumbers Grown in Northern Climate *(Poster Board #108)*

Suman Parajuli* and Chiwon Lee, North Dakota State University

A field experiment was conducted to study the efficacy of using four different mulching materials (clear plastic, black plastic, bio-degradable film, straw) for cucumber production in Fargo, ND. Each of the mulching materials (4-ft wide, 25-ft long) was used to cover each of the raised bed rows (20-ft long, 4-ft between rows) and cucumber seeds were sown in holes made on the mulch 2 ft apart. For the straw mulching, seeds were planted 2 ft apart on the rows and straw was used to cover the row after seedlings emerge from the soil. The experimental layout was a split block system in a randomized complete block design with four replications. Each experiment included 8 treatments representing the combination of four mulch types and two cultivars (Marketmore 76 and Regal F_1). Seeds were sown on June 8 and fruit harvesting continued until Sep 10. During the growing season, soil temperature was taken at 5 and 15 cm below the soil surface and air temperature was taken at 15 cm above the soil surface for each of the mulch type. Fruits were harvested twice a week from 5 plants as sub-plots and 4 replications. For Marketmore 76 (slicing cucumber), plants grown with clear plastic produced significantly higher number of fruits per plant, total fruit yield and number of marketable fruits as compared to non-mulched control. However, fruit yields among four different mulching treatments were not statistically different. For Regal F_1 (pickling cucumber), straw mulched recorded highest value for fruit number and fruit yield than in the control. The average fruit weight, size, tissue pH and Brix reading were unaffected by mulching treatments. The soil temperatures measured at 5 cm and 15 cm depth were highest under clear plastic film compared to other mulches. Soil temperatures under all the mulches were higher during the early growing period. However, differences in soil temperature between mulched and non-mulched control plot became smaller as the plants grew larger covering the entire soil surfaces.

Specified Source(s) of Funding: ND Department of Agriculture Specialty Crop Block Grant

Comparative Pedicel Removal Methodology for New Mexico Green Chile Cultivars(*Capsicum annuum*) *(Poster Board #109)*

Charles D Havlik* and Stephanie J. Walker, New Mexico State University

Currently, New Mexico type green chile is harvested and destemmed (removal of pedicel) by hand during harvest. The pedicel must be removed from fruit destined for commercial processing because stem and calyx material adversely affect product quality. Removal of the pedicel is a continuing challenge in transitioning to a mechanical harvest system that must be addressed by both the development of mechanical destemmers and development of cultivars with relatively easy and clean removal of the pedicel from the fruit. Advanced breeding lines developed for mechanical harvest efficiency were compared to three commercial control cultivars (NuMex Joe E. Parker, AZ-1904, and Big Jim) for force needed to remove the pedicel and efficiency of pedicel removal. Pedicel removal force was measured using a methodology developed in coordination with researchers from UC Davis using a Tohnichi Torque Meter, model BTG90CN-S, fitted with a fork with a chuck gripping mechanism. Using a 1 to 5 rating system, with “1” indicating a failure to remove any of the pedicel (broken stem) and “5” given fruit with complete pedicel removal and no fruit damage. The experiments were conducted at the New Mexico State University Agricultural Science Center in Los Lunas and the Leyendecker Plant Science Research Center in Las Cruces. Random samples of 60 representative full-sized green fruit from each accession were hand harvested with the pedicels intact. Fruit were evaluated for force needed to remove the pedicel and rated to determine how cleanly the pedicel detached. Based solely on “5” rated fruit, torque force units were similar among the accessions. However, when evaluating the percent of fruit that were rated as “5”, breeding line 74W18 (90% fruit rated at “5”) was a superior destemming line compared to the standard control cultivars, Joe E. Parker and AZ-1904 (13.3% and 20.0%) in the Los Lunas plots. Breeding lines 10W18 (70% fruit rated “5”), 13W18 (66.7%), 14W18 (70%), 17W18 (83.3%), and 18W18 (66.7%) all provided more efficient pedicel removal compared to Joe E. Parker (23.3%) and Big Jim (13.3%) at the Leyendecker ASC. Although the removal force was similar in all the lines, based on efficiency of pedicel removal, breeding lines in development for mechanical harvest efficiency were shown to have superior pedicel removal. This attribute will increase the utility of these lines with mechanical destemmer equipment in development that pulls the pedicel off the fruit, but will also aid in pedicel removal by hand harvest.

Production and Storage of Dry-Farmed Winter Squash. *(Poster Board #110)*

Alexandra Stone* and Jennifer Wetzel, Oregon State University

Most winter squash consumed in Oregon from December through April is imported. Locally produced squash rots in storage before December due to a high incidence of blossom end rot (*Fusarium culmorum*). This project evaluated the impact of variety and irrigation on squash production and storage for January sales. Sixteen varieties of squash, including varieties from *Cucurbita maxima*, *C. moschata*, *C. pepo* and one *C. maxima* x *C. moschata* interspecific hybrid ‘Tetsukabuto’ were grown in three split-plot field trials (OSU 2016, OSU 2017, and WhiteOak 2017), with irrigation (overhead vs no irrigation) as the main plot and variety as the subplot. No irrigation is considered dry farming in this region as there is essentially no summer rainfall. All treatments were stored in a barn bay with fluctuating temperature (maintained above freezing) and relative humidity. Dryland yields were 43.0% (OSU 2016), 25.3% (OSU 2017), and 52.4% (WhiteOak 2017) of irrigated yields ($P \leq 0.001$). The highest yielding OSU 2016 irrigated varieties were ‘North Georgia Candy Roaster’ (NGCR, 62.8 tha^{-1}) and ‘Tetsukabuto’ (62.4 tha^{-1}). In OSU 2017, ‘NCGR’ had the highest irrigated yield at 118 tha^{-1} with ‘Small Wonder’, ‘Silver Bell’, ‘Tetsukabuto’, and ‘Early Remix’ coming in second. For dryland production, ‘Small Wonder’ was the highest yielding for OSU 2016 and WhiteOak 2017, at 73.5 and 36.1 tha^{-1} respectively. ‘Small Wonder’, ‘NCGR, and ‘Silver Bell’ had the highest yields for OSU 2017 (26.6, 26.6 and 25.8 tha^{-1} respectively). ‘NCGR, ‘Small Wonder’, ‘Tetsukabuto’ and ‘Early Remix’ were high yielding across all irrigated experiments. ‘Small Wonder’ and ‘NCGR’ were highest yielding across all dryland experiments. Dryland yields were lower in 2017 than in 2016 putatively due to higher daytime temperatures during fruit set and fill. Zero irrigation significantly reduced the incidence of storage rots. In January, the average percent loss in storage was applied to the average yield at harvest to determine the relative yield after four months of storage. Under barn bay conditions, the highest relative yielding varieties under irrigation were 'Tetsukabuto' (45.1 tha^{-1}), 'Small Wonder' (37.1 tha^{-1}), and 'Winter Sweet' (30.0 tha^{1}); for dryland production, the top performers were 'Small Wonder' (45.4 tha^{-1}), 'NCGR (26.7 tha^{-1}), and 'Silver Bell' (24.3 tha^{-1}).

Specified Source(s) of Funding: Western SARE

Yield Comparison of Sweet Potatoes Grown in Four Commercial Organic Soils *(Poster Board #111)*

Steven M. Still*, Murray State University

An experiment was conducted to observe comparative yields of sweet potatoes grown in four different soils; two biochar-based organic soils (A, B), a commercial organic raised bed soil (C), and a commercial premium potting soil (D). No treatments received supplemental fertilization. Yields of above-ground biomass and harvested sweet potato tubers were recorded. Results showed that the average yields (number of tubers and total mass of tubers) of treatments A and B were significantly greater than those of treatment C. The total mass of tubers of treatment B was also significantly greater than treatment D. There was no significant difference in above-ground biomass between treatments A, B, and D, although they were all marginally greater than treatment C. It appears that in the absence of supplemental fertilization, the use of treatments A and B could result in increased yields, compared to treatments C and D, promoting sustainable crop production and food security.

Keywords: Biochar, sweet potato, organic, trough

Specified Source(s) of Funding: Private funding

First Glimpse: Tomato Shading, Experiment Results and Problems. *(Poster Board #112)*

Angela M. O'Callaghan*, Prof and ML Robinson, University of Nevada

Whether growing in a large container on the patio or a row in the home vegetable garden, tomatoes are one of the most popular vegetables in the world, but growing tomatoes in the Mojave Desert is not easy. Heat, low humidity, salty infertile soil and intense sunlight all conspire to foil the home gardener. The choices for Mojave gardeners were either to let the plants die back around June, when weather conditions became extreme, or cut them back at that time, and water through the summer in the hope they revived when temperatures were again in the double digits. Cooperative Extension in southern Nevada has been recommending shading plants in the summer to extend the season, and help improve production as well as quality. The question remained "Does shading up tomatoes really help in a harsh desert climate, and if so, how much shade? Do all tomato cultivars benefit equally?"

We selected four commonly grown tomato cultivars for the experiment: Celebrity, Early girl, Heat Wave and Red Cherry. The treatments were, 0%, 30% and 50% shade. We transplanted seedlings into raised beds with organically amended soils. The land where the raised beds were located where plants had not grown previously. Major problems included wind damage, sunscald, herbivory and root knot nematodes. The project had some noticeable results, indicating that 30% shade gave the best yields. In the 50% shade treatment, the plants grew very large, but had few blossoms or fruit. The high standard deviation made the results not statistically significant. Despite the problems, the data is not useless, and will give guidance to growers. It indicates that we need at least another year of testing.

Specified Source(s) of Funding: Clark County, NV

Grower Adoption of Recommendations to Limit the Spread of Fusarium Wilt of Lettuce in Florida *(Poster Board #113)*

Christian F. Miller*[1]; German V. Sandoya[2]; Jesse Murray[2] and Richard Raid[1], (1)University of Florida - Institute of Food and Agricultural Sciences, (2)University of Florida

Fusarium wilt of lettuce caused by the fungal pathogen *Fusarium oxysporum* f. sp. *lactucae* (Fol) was first reported in the U.S. in 1990, and is now widespread in California and Arizona. The disease was confirmed on symptomatic plants in Florida displaying wilting and vascular discoloration of the taproot for the first time in 2017. Capable of being seedborne, it is suspected that the pathogen arrived on infected seed. The major lettuce growing region of Florida, the Everglades Agricultural Area (EAA), has supported the survival of numerous Fusarium pathogens on a variety of crops over the years and there exists the potential for this lettuce wilt pathogen to thrive there. In response to this new threat, University of Florida research and extension personnel began working with local scouts and area lettuce producers to examine prospects for host-plant resistance in Florida adapted varieties, fungicidal control, sanitation procedures, and cultural management options to slow the spread of Fol. Pathogen isolates were collected for pathotyping and the geographical distribution throughout the EAA was recorded. An initial grower workshop was held in the spring of 2018 to educate members of the Florida lettuce industry regarding Fol biology, symptoms, impact elsewhere, and potential mitigation tactics. A post-reflective survey conducted at the conclusion of the grower meeting indicated significant knowledge gain by the attendees. In the fall of 2018, select lettuce growers and crop consultants representing 90% of the 15,000 acres of lettuce farmed in the EAA completed a follow-up survey to determine which, if any, behavior changes were implemented as a result of the previous educational workshop on the Lettuce Wilt pathogen. Adoption of UF/IFAS recommended management strategies designed to limit the spread of Fusarium wilt of lettuce were acknowledged by 63% of the respondents. Among the new practices employed by these lettuce producers are dedicated tools and equipment for fields where Fol is known to be active and sanitization of tools and equipment after use in such fields. These and other management efforts being utilize to slow the spread of Fol by local growers are being evaluated as the 2019 growing season progresses.

Evaluation of Enzymatic Profiles and Plant Growth Promoting Traits of Selected Biological Agents Mediating Their Biocontrol Activity Against Fungal Pathogens. *(Poster Board #114)*

Margaret T, Mmbaga*; Asha Maheshwari and Ethane Swiggart, Tennessee State University

Farming communities heavily rely on the use of agrochemicals as a routine practice to improve plant production. This has increased concern over the undesirable consequences of chemicals on human health and environment. This has encouraged extensive research to reduce the dependence on agrochemicals and by developing safer and economically viable alternatives. Significant progress has been made to search for reliable and efficient biological agents. However, studies have shown that effective plant colonization by biological agents significantly impact disease suppression and improve plant growth. In recent years, research on antagonistic endophytes that grow inside plants without causing symptoms has has shown their ability to naturally colonize same ecological niches as pathogens and grow rapidly in interstitial spaces of host tissues. These organisms are likely to be effective in suppressing plant pathogens. In this study, isolates of endophytic bacterial were evaluated for control of plant pathogens and for attributes such as production of hydrolytic enzyme, growth promoting compounds and enzymes associated with biological control of phytopathogenic fungi. This study focused on the bacterial endophytes isolated from *Cornus florida*, *Phaseolus vulgaris* and *Carica papaya* which were previously reported to have biological control against diverse fungal pathogens and also promotes plant growth.Our studies confirmed that these bacterial endophytes produce cell wall degrading enzymes and possess diverse plant growth promoting traits such as IAA synthesis, phosphate solubilization, nitrogen fixation produce ammonia and siderophores. Growth promotion by these endophytes may result from combined effects of one or more plant growth promoting traits. Our findings also demonstrated that the endophytes produce volatile compounds that also played significant role in promoting plant growth displayed on both shoot and root growth.

Specified Source(s) of Funding: USDA/NIFA Award No. 2010-38821-21477

Potential of Beneficial *Trichoderma* Isolates in Alleviating Drought Stress in Tomato *(Poster Board #115)*

Ranjana Rawal*[1]; Joseph C. Scheerens[2] and Maria Soledad Benitez[1], (1)Ohio State University, (2)The Ohio State University-OARDC

Tomato (*Solanum lycopersicum*) is the world's second most important vegetable crop in terms of per capita consumption. Currently global productivity of tomato is challenged by different environmental stresses especially drought due to inadequate irrigation and erratic rainfall. In recent years, naturally occurring beneficial soil microorganisms are receiving increased attention as a sustainable tool for improving crop production and inducing stress tolerance in both research and commercial production. The fungal genus *Trichoderma* exists ubiquitously in soils worldwide and members of this genus are well-known to colonize plant root forming symbiotic relationships that promote plant growth, especially under adverse environmental conditions (e.g., drought, salt stress, nutrient deficiency). But the efficacy of colonization can be isolate specific, and the beneficial effect of *Trichoderma* may depend on the specific plant genotype. Therefore, the overarching goal of this project is to examine the potentiality of *Trichoderma* isolates, primarily native to Nepal, to ameliorate drought stress in tomato. Forty-one *Trichoderma* isolates were collected from various agro-ecological regions of Nepal (i.e., wet to dry). In addition, two *Trichoderma* isolates from Ohio and a commercially available form of *Trichoderma harzianum*-TH22 were selected for this study. An in-vitro assay was undertaken to identify *Trichoderma* isolates with potential to survive in low moisture environments. Only fourteen isolates were selected as desiccation tolerant as they were able to grow at low moisture content of -8.5 Matric potential induced by polyethylene glycol 8000 in Potato Dextrose Agar plates. Twenty-four isolates were further tested for tomato growth promotion and drought tolerance capacity under greenhouse conditions. Under irrigation, twelve isolates resulted in greater plant biomass, compared to the non-inoculated control. Furthermore, a subset of isolates resulted in greater tomato performance under drought. Out of 24 *Trichoderma* studied, five (T3, T-16, T-31, T33, T37, T43, T44) showed lower wilting symptoms under drought and recovered faster after irrigation. In addition, tomato plants treated with isolates T16, T31, T33, T37 had 25-30 % more shoot biomass as compared to control under the drought stress condition. Isolates T16, T31, T33, T37 were originally collected from the drier areas of Nepal and were capable to promote growth under drought stress, as compared to those collected from wet areas, indicating a potential adaptation to this extreme condition.

Specified Source(s) of Funding: Schlumberger Foundation Faculty for the future

Watermelon Field Evaluation of Fruit Maturity for New and Existing Grafting Methods *(Poster*

Board #116)

Scott B. Lukas*, Oregon State University, HAREC; Carol A. Miles, Washington State University, NWREC and Pinki Devi, Washington State University

Grafting watermelon with suitable rootstock can be effective to control biotic and/or abiotic stresses that significantly impact production in the Pacific Northwest region of the United States. Despite well-established benefits, growers have been slow to adopt watermelon grafting on a large scale, partially because of the high cost of grafted transplants produced by commonly used grafting methods and partially due to some reports showing reduced fruit quality. When using grafted watermelon plants, regardless of grafting method, harvest timing needs to be re-evaluated for traditional harvest indicators (e.g., dry leaflet and tendril attached to the fruit pedicel) as fruit from grafted plants can be slightly immature, resulting in undesirable fruit quality. Furthermore, grafted rootstock can affect the timing of male and female flowering of watermelon, thereby affecting fruit maturity and harvest dates. Thus, it is difficult to harvest ripe fruit from grafted and non-grafted plants concurrently, leading to conflicting reports regarding the quality of grafted watermelon. Splice grafting is the fastest and most efficient grafting method, and solanaceous crops are grafted exclusively using this method. Research at Washington State University has shown that splice grafting can be successful for watermelon grafting with 60-90% survival in the greenhouse. Now research is needed to evaluate field survival of splice-grafted watermelon transplants and impacts of this grafting method on crop development. The objectives of this trial are to 1) evaluate the survival of splice-grafted watermelon in both the greenhouse and field; 2) measure the effect of grafting method on flowering date; and 3) establish harvest indicators to be used by growers in the area and test their effect on fruit quality. The experimental trial is located at the Oregon State University, Hermiston Agricultural Research and Extension Center and designed as a random complete block with six replications. Two commercial interspecific hybrid squash rootstocks cvs. Tetsukubato and Super Shintosa, with two grafting methods, the splice method and the one-cotyledon method are being evaluated with scion cv. Secretariat. This study will help develop field performance attributes and harvest indices of watermelons grafted using both methods. Measurements will ascertain field survival and plant health parameters, as well as flowering time, indicators of harvest time, and internal fruit quality affected by grafting with both methods. Results will be presented for our field trial conducted in summer 2019, thus pre-harvest measures will be discussed, such as plant survival and health, and flower initiation data.

Undergraduate Student 1 (Poster)

Accuracy and Ease-of-Use Evaluated for Several Different Chlorophyll Meters *(Poster Board #001)*

Kenneth J. Sweeney*[1]; Malcolm M Manners[2] and John L. Griffis Jr.[1], (1)Florida Gulf Coast University, (2)Florida Southern College

There are many reasons why researchers need to determine accurate leaf chlorophyll content. The standard procedure of removing leaves and extracting chlorophyll can easily be done, but this destructive sampling of leaf tissue is not always possible as some plants have very few leaves. Several different meters that have been introduced to the US market claim to determine leaf chlorophyll content indirectly, using either transmitted or reflected light. Ease-of-use, software, and purchase prices are considerably different between the various meters. In this study, we compared the effectiveness of these chlorophyll meters at measuring leaf chlorophyll content in *Homalomena* ‘Emerald Gem’. The plants were grown in a Florida greenhouse using a split-block design with two light levels and three fertilizer rates. There were four plants per block for each treatment and three blocks. The chlorophyll content of the newest mature leaf was measured monthly for six months using four chlorophyll meters: Apogee MC-100, atLEAF CHL PLUS, Opti-Sciences CCM – 300, and Konica Minolta SPAD-502 Plus. Additionally, the color of the leaves was measured using the NIX Pro handheld color sensor. Bimonthly, DMSO was used to extract chlorophyll from leaf discs and subsequent spectrophotometric analysis was completed at 649nm and 665nm for chlorophyll concentration comparison. The accuracy of the meters were compared to each other and to the chemical spectrophotometric analyses. Ease of use for each of the meters was also evaluated.

Examining Pathogenic Variation and Host Plant Response to Eastern Filbert Blight in Hazelnut Cultivars Protected By the ‘Gasaway’ Resistance Gene *(Poster Board #002)*

Ash Dunlevy*; Michael P. Gandler; David Hlubik; John Michael Capik and Thomas J. Molnar, Rutgers University

Eastern filbert blight (EFB), caused by *Anisogramma anomala*, is a primary limiting factor of hazelnut cultivation in North America. The fungus, native to the eastern US and southern Canada, causes severe stem cankers and branch die-back on susceptible plants, which includes most cultivars of European hazelnut, *Corylus avellana*. Fortunately, the pollenizer ‘Gasaway’ was identified as resistant in the 1970s and found to transmit a dominant allele at a single locus that confers resistance to EFB. To date, ‘Gasaway’ has been used in breeding at Oregon State University to develop improved, EFB-resistant cultivars for the Oregon hazelnut industry, which produces 99% of US hazelnuts. However, research at Rutgers University showed that some of the ‘Gasaway’ protected plants, while remaining resistant in Oregon, developed EFB in the field in New Jersey. Fortunately, most infections remained minor, with reduced canker lengths and fewer cankers per stem compared to known susceptible plants. This scenario changed dramatically in

2016 when multiple 'Gasaway' protected plants were found to express a high number of large cankers. The following two years confirmed this apparent change in response to EFB, with many trees, including 'Gasaway' itself, showing significant amounts of disease unlike that previously reported. To examine this observation more critically, controlled inoculations were performed using *A. anomala* collected from these large cankers and applied to replications of five cultivars (Yamhill, Jefferson, Dorris, McDonald, and Felix) that carry the *R*-gene. A similar control population was exposed to *A. anomala* using inoculum collected from known susceptible trees lacking the *R*-gene. Results showed that 87% of the trees exposed to the "Gasaway" inoculum expressed EFB. This is in contrast to only 20% of trees exposed to the "general" inoculum developing cankers. Further, the average proportion of disease wood of the infected trees in the "Gasaway" inoculum group was 21.7%, whereas the proportion of disease wood in the "general" inoculum group was only 6.7%. Finally, the average canker length of the "Gasaway" and "general" group was 30.1 cm and 9.7 cm, respectively. These results strongly suggest a difference in virulence between the two sources of inoculum, and when combined with the field observations, suggest that a 'Gasaway'- virulent strain of *A. anomala* is now present in New Jersey that greatly reduces the effectiveness of the *R*-gene. A second round of the study, supported by DNA fingerprinting of the fungus, is underway.

Specified Source(s) of Funding: USDA-NIFA Specialty Crops Research Initiative Competitive Grant 2016-04991 and 2009-51181-06028

Ppe-Xap a DNA Test for Routine Prediction in Breeding of Peach Bacterial Spot Fruit Resistance *(Poster Board #003)*

Texanna Miller*; Margaret Fleming; Sarah B. Miller; Christopher Saski and Ksenija Gasic, Clemson University

Bacterial spot, caused by *Xanthomonas arboricola* pv. *pruni*, is a serious economic disease causing severe defoliation and black surface pitting, cracking or blemishes on peach fruit worldwide. A management option for control and meeting consumer demand for chemical-free, environmentally friendly fruit production is the development of resistant or tolerant cultivars. Resistance to bacterial spot in peach cultivars is under polygenic control. Several controlling loci in the peach genome conferring quantitative resistance were recently discovered in an F2 population. The frequency and effect of two quantitative trait loci (QTLs) with the largest effects on bacterial spot resistance in peach fruit, *Xap.Pp.OC-1.2* and *Xap.Pp.OC-6.1*, were evaluated in a large collection of U.S. peach breeding germplasm. Previously developed SSR tests Ppe-Xap-LG1 and Ppe-Xap-LG6 (www.rosbreed.org) were partially accurate in determining Xap alleles in breeding material. Therefore, we developed Ppe-Xap DNA test based on KASP technology to aid in accuracy and efficiency in culling seedlings at the greenhouse stage. The objective of this research was to validate newly developed Ppe-Xap DNA tests, targeting the two major QTLs for fruit resistance in peach, for their prediction of fruit response to bacterial spot infection. Ppe-Xap KASP test genotyping efficiency in new peach breeding germplasm and its prediction accuracy and breeding utility in Clemson University peach breeding program will be presented.

Specified Source(s) of Funding: USDA-NIFA-SCRI-RosBREED (2014-51181-22378)

Evaluating Vitis Vinifera Productivity in Sheridan, Wyoming *(Poster Board #004)*

Heidi Moriah Schueler*[1]; Ami N. Erickson[1] and Alisha K. Bretzman[2], (1)Sheridan College, (2)University of Wyoming

Evaluating Vitis vinifera Productivity In Sheridan, Wyoming
Heidi Schueler and Alisha Bretzman with Ami Erickson

Agriculture Department
Sheridan College - Northern Wyoming Community College District and University of Wyoming - Sheridan Research and Extension Center

Poster

In the summer of 2014, 350 Vitis vinifera (grapevines) originating from the USDA cold-hardy grapevine germplasm repository in Geneva, NY were planted in Sheridan, Wyoming at the Sheridan Research and Extension Center. Thirty-five different cultivars were planted and evaluated for winter survival and bud break. Based on 2015 data survival rate was 73% and average bud break began on May 14th- June 9th. Certain cold hardy varieties had a 100% survival rate, including: 'Marechal Foch' and 'Osceola Muscat' and 'Frontenac' (Dhekney et al. 2015). Grape production has many challenges in Wyoming, including: deep winter freezes and mid-winter thaws; early spring frosts; early fall frosts; a dry, windy climate; and poor ground water quality. Despite these challenges, many of the original 350 vines that were planted have survived and have begun to produce. However, little data is currently available. Our goal for the 2019 growing season is to identify which of the 35 cultivars holds a profitable yield potential for grape production in Wyoming. We will base our evaluation on factors including growing degree-days (GDD) on bud break and grape harvest, weight and size of grape clusters, grape sugar concentration, and overall health of the vines. Growing degree-days typically begin in late March to early April and end in October. Growing degree-days are expressed as temperatures above 50° F, when bud break and cell division can take place. From observations of fall 2018 harvests, we expect to see potential profitable yield from 'Frotenac', Frontenac Gris' and 'Osceola Muscat.'

Specified Source(s) of Funding: INBRE

Propagation of Hardy Begonia from Seeds and

Tubers *(Poster Board #006)*

Zoe V. Schroeder*; Robert L Geneve and Sharon Kester, University of Kentucky

Hardy begonia (*Begonia grandis subsp. evansiana*) is one of the tuber-producing begonia species and is the only frost-hardy begonia (USDA Zone 6). Hardy begonia has received a revival in popularity as a shade-tolerant, summer flowering perennial. It apparently survives winter temperatures as basal or dispersed aerial tubers. Aerial tubers form late in the summer under short daylengths. There is limited information on the propagation of hardy begonia related to seed or tuber propagation. Hardy begonia flowers in late summer and fruits often do not reach full maturity before frost. Seed harvested from swollen fruits following petal abscission were collected and dried under ambient lab conditions. Seed harvested from dried capsules collected from fruit prior to observable natural desiccation had a mixture of filled and unfilled seeds and filled seeds from these fruits germinated slowly (>two weeks). Seed harvested from dried capsules collected from fruit showing some observable natural desiccation had a higher percentage of filled seeds and these seeds germinated in less than one week. Aerial tubers form in leaf axils and tuber size varied based on node location on the plant. Tubers of various sizes were placed in a petri dish with vermiculite and placed at 10C for 0 to 10 weeks. Tubers did not form plants without a chilling treatment. Plant formation began after four weeks of chilling, but the highest plantlet formation occurred after six and ten weeks of chilling. There was no difference observed based on tuber size, but larger tubers produced larger plantlets. Tubers showed polar development with shoots forming only at the apical end of the tuber. In vitro shoot cultures were established for seeds, tubers and tuber-derived shoots. In initial studies, cultures derived from seedlings produced the most vigorous cultures. Studies are ongoing to investigate the cultural parameters (cytokinin, sugar concentration, photoperiod) that support in vitro tuber induction.

Effect of Gibberellic Acid in Breaking Seed Dormancy of Excised *Sphaeralcea coccinea* (Nutt). Embryos *(Poster Board #007)*

Alisha K. Bretzman*[1]; Ami N. Erickson[2]; Robert Milne[2]; William Hoch[3] and Brian Mealor[1], (1)University of Wyoming, (2)Sheridan College, (3)Montana State University

There is a growing demand for sustainable horticultural crops, and more specifically, drought -tolerant native plants. However, some native plants are difficult to cultivate due to lack of seed availability, poor quality or expensive seed, lack of propagation knowledge and hard-to-propagate seed properties. *Sphaeralcea coccinea* is native to arid regions of the Western United States and Canada and has many valuable characteristics as a horticultural crop, but it is a hard-to-propagate species due to its hard seed coat and impermeable substances within the seed. Plant tissue culture technology, specifically *in vitro* embryo culture, is an effective method to quickly break seed dormancy and provide plantlets for transplant to soil and growth to maturity. For this study we evaluated the effect of MS media modified with five levels of gibberellic acid (GA) (1µm, 2µm, 4µm, 8µm, and 16µm) on *S. coccinea* embryos. Seeds were first subjected to a 40 minute sulfuric acid (18M) soak to dissolve the seed coat for dissection and excision of the embryo under sterile conditions. Excised embryos were transferred to petri dishes containing sterile MS media (control) and MS modified with sterile filtered GA. Petri dishes were maintained at 24+/-1 °C in the dark. Germination was judged by radical expansion of 2mm in length and recorded daily for 7 days. It is hypothesized that increasing rates of GA will lead to increased germination rates.

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Specified Source(s) of Funding: INBRE

Wednesday, July 24, 2019

Citrus Crops 2 (Poster)

Physiological Changes of Citrus Tree and Fruit By Frost Damage in Korea *(Poster Board #305)*

Younghun Choi*; Gyeong-rok Yang; Seokbeom Kang Sr.; Haejin Lee; Jae Ho Jao and Youngeel Moon, National Institute of Horticultural & Herbal Science, RDA

The unexpected extraordinary cold wave occurs irregularly in Korea due to abnormal climate change. This unusual climate affects on the growth and development of citrus tree and fruit. This research was conducted to investigate the cold tolerance on citrus cultivars and the mechanism of frost damage by the analysis of tissue change on low temperature conditions. The exothermal point was determined by temperature measurement sensor on surface of leaves in seconds until –30°C. The value of median lethal temperature(LT50) was determined by the amount of the produced electrolyte after the treatments under 6 different low temperature conditions for 1 hour respectively. And LT50 was calculated by Gompertz function equation after the integration of the measured values. Soluble solid content was increased, and O7 gene was down-regulated in leaves of the cold acclimated citrus cultivars. That is, the results shows the frost damage affects on the physiological changes of citrus tree, growth disorder, and fruit quality.

Genome-Wide Analysis of Cold Signaling-Related Genes in Cold Hardy *Poncirus Trifoliata* *(Poster Board #307)*

Ze Peng*[1]; Guohong A. Wu[2]; Jessen Bredeson[3]; Shengqiang Shu[2]; Daniel S. Rokhsar[2]; Fred Gmitter[1] and Zhanao Deng[1], (1)University of Florida, (2)U.S. Department of Energy Joint Genome Institute, (3)University of California, Berke-

ley
Cold is a major limiting, even highly lethal, factor of citrus production worldwide. *Poncirus trifoliata*, a close relative of *Citrus* species, is extremely cold-hardy and has contributed its cold tolerance to many rootstocks widely used in the citrus industry in the world. Currently, the genes and genetic mechanisms for cold tolerance in *Poncirus* remain to be fully understood. We performed a comprehensive search for cold signaling-related genes in *P. trifoliata,* six *Citrus* species, and a primitive *Citrus* relative *Atlantia buxifolia*, using their orthologs that have been identified and characterized in *Arabidopsis*. The gene family analysis revealed a total of 46 gene families containing *P. trifoliata* genes and cold signaling pathway genes characterized in *A. thaliana*, such as *CBF2*, *ICE1*, *MPK*, and *CAMTA*. Additionally, there are 50 *P. trifoliata* gene families orthologous to either the first-wave transcription factor genes responsive to cold stress or *CBF* regulon genes in *A. thaliana*. For most of these gene families, *P. trifoliata*, *Citrus* species and *A*. *buxifolia* have equal or similar numbers of genes across the species. However, several gene families are present only in cold-hardy *P. trifoliata* and/or *Citrus ichangensis* but absent in cold-sensitive *C. maxima* and *C. medica*, and several other gene families have different numbers of genes between cold-hardy and cold-sensitive species. Among the genes specific to *P. trifoliata*, six were previously identified as being responsive to cold stress. Previous studies indicated that the hybrid proline-rich protein gene (*PRP*) positively regulates cold tolerance in *P. trifoliata*. Our analysis showed that *P. trifoliata* has two *PRP* genes (9 kb away from each other) while cold-sensitive *Citrus* species have only one *PRP* gene. The discovered gene families may play an important role in conferring cold tolerance in *Poncirus*. These findings may help understand the molecular mechanisms of cold tolerance in *P*. *trifoliata* and advance the development of cold-tolerant *Citrus* varieties.

Specified Source(s) of Funding: CRDF Project #724

Optimal Nutrient Concentrations and Use of Root Growth Enhancers to Improve Citrus Root Health *(Poster Board #308)*

Lukas Hallman*; Lorenzo Rossi; Walter O. Ac Pangan and Sawyer N. Adams, University of Florida

Root structure and function is an understudied component of citrus research, especially now, in the age of Huanglongbing (HLB) disease. A better understanding of how roots react to different nutrient concentrations and root enhancers can potentially lead to better management options in the future. Fertilization guidelines utilize leaf nutrient concentrations to generate fertilizer recommendations for N, P, K, Ca, Mg, and micronutrients. Interestingly, there are currently no guidelines for optimal nutrient concentrations in healthy roots. A greenhouse study was conducted on twenty-five lemon trees and twenty-five oranges for 6 months. Lemon (var. Bearrs Lemon) and orange (var. Valencia) trees grafted on ‘Sour Orange’ rootstocks were employed. Five different treatments were designed to test different Osmocote (15-8-11) fertilizer concentrations in combination with a commercial root growth enhancer (oGRO). The overall treatments were: (a.) 150 gr/kg Osmocote (Control), (b.) 150 gr/kg Osmocote + 1% oGRO, (c.) 150 gr/kg Osmocote + 0.5% oGRO, (d.) 75 gr/kg Osmocote + 1% oGRO, (e.) 75 gr/kg Osmocote + 0.5% oGRO. Five repetitions were used for each treatment. The lemon and orange trees were grown in natural sand collected from the UF/IFAS IRREC experimental field. During the experiment, height, trunk diameter and stomatal conductance were measured every 15 days for 6 months. At the end of the experiment fresh and dry weights were determined. Similarly, nutrition concentrations (N, P, K, Mg, Mn, B, Ca, etc.) in leaves, stems and roots and leaf chlorophyll contents were analyzed. Photos of each plant were also taken to analyze root system architecture responses to different treatments. As a result, the orange trees treated with more fertilizers and more oGRO showed enhanced physiological and nutritional levels, while the lemon trees showed significant changes in chlorophyll contents and root growth and development. The results clearly indicate a role of genotype (lemon vs. orange) in response to different nutrition levels.

Specified Source(s) of Funding: UF/IFAS Research

Comparing Root Distribution in Two Orange Groves with Different Floor Management and Irrigation Practices *(Poster Board #309)*

George Thomas III*[1]; Juan Enciso[2]; Veronica Ancona[3]; Mamoudou Setamou[3] and Catherine Simpson[3], (1)Texas A&M University-Kingsville, (2)Texas A&M Agrilife Research, (3) Texas A&M University, Kingsville Citrus Center

The citrus industry is one of the most important in the US, but has also faced many challenges in recent years due to citrus greening disease. This has been exacerbated by additional diseases, natural disasters, drought, and water allocations. The South Texas region, including the Lower Rio Grande Valley (LRGV), ranks third in the nation in citrus production and produces more than 250,000 tons of fruit annually. However, production is often limited due to a variety of factors out of the control of the producers. Some of these factors include increasing temperatures and drought which both play key roles in total yield. Additionally, water availability is affected by soil and management practices which can impact tree health and production. Grove floor management practices and irrigation can affect citrus root health and distribution within the soil profile due to distribution of moisture and nutrients. The objective of this study is to compare growth and root systems of young orange trees in two different groves which are managed and irrigated differently. The management practices examined in this study are: flat beds, raised beds, with and without groundcovers, with one site irrigated via flood and the other with drip. Citrus roots were collected and measured using WinRHIZO software to analyze the differences in root distribution and morphology. Analysis of roots in varying management and irrigation practices will provide a deeper understanding of how root environment affects root distribution and morphology in citrus.

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Differential Sensitivity to Abscission Chemicals in Citrus Rootstocks Influence Abscission Dynamics in Scions *(Poster Board #310)*

Fernando Alferez and Daniel Adu Boakye*, University of Florida

In this work, we compared the abscission dynamics of citrus rootstocks US-802, US-897 and US-942, and how they may affect abscission in the grafted variety. This may have profound implications for the fruit lifespan on the tree, affecting final yield. Rootstocks selected are among the most demanded by growers in Florida. We used an in vitro explant system that allow a high number of comparisons in a short period of time to study abscission in leaf explants in response to increasing concentrations of 1-aminocyclopropane-1-carboxylic acid (ACC). Treatments were water, 0.1mM ACC and 1mM ACC on US-802, US-897 and US-942 rootstock leaf explants, and on 'Valencia' and 'Hamlin' leaf explants from mature trees grafted on these rootstocks. Then, we compared these results with smaller in vitro trials on detached fruit and stems. Leaves of all three rootstocks responded differently to ACC advancing abscission, being US-897 more resistant to abscise. By 6 days of 1mM treatment, 95% of US-802 and US-942 explants were abscised as compared to only 40% of US-897 explants. Similar but muted results were observed in 'Hamlin' and 'Valencia' leaves, since differences here were visible only at lower (0.1mM) ACC concentrations, but not at 1mM. At this higher concentration both varieties had the same abscission dynamics irrespective of the rootstock, and by day 4, 100% of explants had abscised. Abscission and sensitivity to ACC in detached rootstock fruit was advanced with maturation irrespective of ACC concentration. In mature fruit, abscission dynamics was accelerated in US-942 and US-802 as compared to US-897. This is coincident with the results obtained in leaf explants. Abscission in 'Hamlin' and 'Valencia' fruit was also affected by the rootstock, but to a lesser extent. In general, fruit from 'Hamlin' on US-942 was more prone to abscise than on US-897, whereas in 'Valencia' there was less fruit abscission irrespective of the rootstock. Taken together, these results show how rootstock selection may affect fruit lifespan and ultimately, yield of sweet oranges in Florida.

Effects of Soil Salinity on Citrus Rootstock 'US-942' Physiology and Anatomy *(Poster Board #311)*

Lorenzo Rossi*; Sawyer N. Adams and Walter O. Ac Pangan, University of Florida

The accumulation of salt deposits in the soil is becoming a major problem in agriculture. The problem can affect citrus production, which is already seriously hindered in Florida by the disease known as Huanglongbing (HLB, or citrus greening). With the citrus industry declining it is imperative to study all the potential environmental stresses affecting the citrus cultivation and to conduct screening tests to evaluate which rootstock perform best under these new challenging conditions. This study aims to determine how the 'US-942' rootstock reacts to salinity. Thirty-six 3-month-old 'US-942' citrus rootstock seedlings were grown in a greenhouse. After 15 days of acclimation, plants were assigned to one of six groups and treated for 30 days with solutions of 25% Hoagland solution amended with 0 (control), 30, 60, 90, 120, or 150 mM NaCl. Higher NaCl concentrations significantly hindered plant growth and negatively affected the physiological processes (*i.e.,* stomatal conductance and chlorophyll contents). Conversely, plants treated with mild concentrations (30 mM NaCl) had higher plant biomass and exhibited higher photosynthetic efficiency. Free hand sections of fresh roots were taken at the end of the experiment and the suberin lamellae development was examined under a fluorescence microscope. In conclusion, results reported that 'US-942' rootstock is tolerant to mild salt stress and confirmed the hypothesis that the formation of root apoplastic barriers and the increase in the root biomass could be two of the possible mechanisms that give the 'US-942' a mild NaCl stress tolerance.

Specified Source(s) of Funding: UF/IFAS Research

Response of Citrus Rootstocks to Irrigation Water pH *(Poster Board #312)*

Lushan Ghimire* and Tripti Vashisth, University of Florida

The alkaline pH of the soil and irrigation water in Florida can exacerbate Huanglongbing (HLB) symptoms on citrus. In addition, soil pH of root zone can directly affect nutrient availability and influence root health, and when low/excess can stress root cells through the accumulation of reactive oxygen species. Altogether, optimal soil pH is critical for good performance, and productivity of crops. Although, number of rootstocks that are potentially tolerant to HLB have been released in the past few years, their response to different pH conditions has not been critically evaluated. Thus, understanding the mechanism of high-pH induced damage on citrus is required to minimize existing losses. Therefore, the objectives of this experiment were to understand the effects of different irrigation/soil pH on the performance of commercially used citrus rootstocks and to relate high-pH stress responses with oxidative stress. Seedlings of seven citrus rootstocks: Kuharske citrange, Swingle citrumelo, US-896, UFR-4, UFR-16, US-802, and 46X20-04-6, were chosen for study based on breeder recommendation, commercial use, and prompt availability. Plants were arranged in randomized complete block design (n=8) and irrigated every 2-3 days with sodium phosphate buffers at pH 5.8, 7.0 and 8.0 and with deionized water for control. Plant performance was monitored for a period of 7 weeks. Membrane injury on root tissue estimated through percentage electrolyte leakage was observed to be the least under control conditions and significantly increased with increase in pH from 5.8 to 8.0. Swingle, US-802, and US-896 showed similar nutrient uptake at pH 5.8 and pH 7.0 as explained by the electrical conductivity (EC) readings. However, EC increased significantly with the increase in pH among all the rootstocks. Swingle, Kuharske, and UFR-16 rootstocks had the highest percentage increase in leaf number under control and pH 5.8 treatments and the least under pH 8.0 treatment. US-802, US-896, and 46X20-04-6 rootstocks performed comparably at all three pH ranges and had similar percentage increase in leaf number. All three pH treatments had resulted in similar leaf fresh weight in Swingle, US-802, UFR-16, 46X20-04-6, and UFR 4 rootstocks. pH did not affect root fresh weight among any of the rootstocks which could be due to its effect on light weight-feeder roots. Overall, pH 8.0 was found to be affecting the overall plant growth in most of the rootstocks. Measurement of reactive oxygen species levels and enzyme activity is still underway to understand their role in stress due to high-pH irrigation.

Genetics & Germplasm 2 (Poster)

Fruit Quality and Phenolic Diversity in the USDA Tart Cherry Collection *(Poster Board #219)*

Benjamin Gutierrez*[1]; Heidi Schwaninger[1]; Jie Arro[1]; Kenisha Ross[2]; Kayla Aulet[2] and Gan-Yuan Zhong[1], (1) USDA-ARS Plant Genetic Resources Unit, (2)Hobart and William Smith Colleges

Anthocyanins play a critical role in cherry quality by contributing to fruit color and nutritional value. Anthocyanin profiles in tart cherry are distinct from sweet cherries. Cyanidin 3-rutinoside is the primary anthocyanin in sweet cherries (*Prunus avium*), whereas tart cherries (*Prunus cerasus*) accumulate cyanidin 3-glucosyl-rutinoside as the primary anthocyanin and cyanidin 3-rutinoside as a secondary. Our objective was to evaluate the phenolic composition of the USDA-ARS Tart Cherry collection (n=130) located in Geneva, NY. Fruit was harvested at maturity in 2011, 2013, and 2014 and stored at -80°C. Phenolic content was measured using high performance liquid chromatography. Additional fruit quality traits were scored, including: total soluble solids, titratable acidity, and fruit and pit weights. Genetic markers were developed using Genotyping-by-Sequencing using the *P. avium* genome reference. We observed substantial variation in anthocyanin content, particularly in comparison with standard cultivar 'Montmorency' (PI 592845), with total anthocyanin content ranging from 72.9 to 2,095.9 $\mu g\ g^{-1}$. Additionally, we identified potentially misclassified tart cherry accessions with genetic and anthocyanin profiles better fitting sweet cherries.

Specified Source(s) of Funding: USDA-ARS Plant Genetic Resources Unit

Genetic Diversity and Population Structure Analysis of *Vaccinium Corymbosum* Assessed By Double Digest Restriction-Site Associated DNA Sequencing *(Poster Board #220)*

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Southern highbush blueberry (SHB) was developed by crosses between northern highbush [NHB (*V. corymbosum* L. 2*n*=4*x*=48)] and Florida's indigenous blueberry species (*V. darrowii* Camp. 2*n*=2*x*=24) to expand the geographic limits of highbush blueberry production. Due to the multiple times use of interspecific hybridization in breeding process, all SHB cultivars are assumed to contain genomic segments introduced from one or more of the *Vaccinium* species, resulted in germplasm showing phenotypic variation for different traits. Because of the complex genome and lack of molecular tools, the genetic diversity and population structure of SHB germplasm have never been fully assessed. In this study, a double digest restriction-site associated DNA sequencing (ddRAD-seq) method was used to analyze the population structure and asses the genetic diversity within a panel of 168 SHB accessions, 30 NHB accessions, 15 rabbiteye blueberry [RE (*V. virgatum* Aiton 2*n*=6*x*=72)] and 10 diploid species including *V. darrowii, V. corymbosum, V. elliottii, V. tenellum,* and *V. pallidum*. Structure analysis indicated that SHB contains genomic segments introduced from other *Vaccinium* species. Principal component analysis revealed that RE cultivars could be clearly distinguished from highbush cultivars. Although NHB and SHB were grouped together, we were able to find principal components that partially discriminate between them.

Genetic Characterization of Fire Blight Resistance in Three Pear Populations *(Poster Board #221)*

Jason D. Zurn*, USDA-ARS NCGR; John L. Norelli, USDA-ARS; Sara Montanari, University of California; Richard Leslie Bell, USDA ARS and Nahla Bassil, USDA-ARS Corvallis

Fire blight, caused by *Erwinia amylovora*, is the most devastating bacterial disease of pear (*Pyrus* spp). This disease is a constant problem for the primary pear production areas of the U.S. Planting resistant cultivars is the best option for managing fire blight. Unfortunately, all major cultivars grown in the U.S. are susceptible to this disease. The cultivars Potomac and Old Home and the selection NJA2R59T69 are resistant to fire blight and can be used to create new cultivars with traits desired by growers and consumers. Therefore, three mapping populations ('El Dorado × 'Potomac', 'Old Home' × 'Bartlett', and NJA2R59T69 × 'Bartlett') were developed to identify genomic regions associated with fire blight resistance. The populations were initially genotyped with a DNA fingerprinting set to identify progeny that were the result of an unexpected pollination event. Progeny which had the expected pedigree were selected for continued analysis and were genotyped with the recently developed Axiom Pear 70K Genotyping Array. In 2017 and 2018, multiple actively growing shoots of field grown seedling trees were inoculated with *E. amylovora* E153n via the cut leaf method. The percentage of current season's shoot that was blighted was calculated. The phenotypic distributions for each population were severely skewed toward resistance and the number of genes mediating resistance could not be easily discerned. Chromosomal linkage groups were established for each population using a cross-pollinating mapping approach with JoinMap 5. Each map had approximately 30,000 markers distributed across the whole genome. The average total length of the high quality maps was 1,087 cM. An integrated two-way pseudo-testcross approach was used to map QTLs using MapQTL 6. A single significant QTL ($\alpha = 0.05$) mediating resistance was identified for each population in a similar region on chromosome 2. Fire blight resistance QTLs have been previously reported in this region for 'Harrow Sweet' and 'Moonglow' (a parent of 'Potomac'). The presence of the chromosome 2 QTL in NJA2R59T69 is interesting as the resistance originated from the *P. ussuriensis* selection 'Illinois 76' and not a *P. communis* source like 'Potomac' and 'Old Home'. This could suggest that the resistance in this region may be due to a conserved basal defense response. Additional work is needed to further characterize this unique genomic region.

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Population Structure and Diversity Estimates in a Geographical Core Set of Radish (*Raphanus sativus*) *(Poster Board #222)*

Jie Arro*, USDA-ARS Plant Genetic Resources Unit and Joanne A. Labate, USDA-ARS

Radish (*Raphanus sativus*) is an ancient crop native to the Eastern Mediterranean and Eastern Asia. Radish is consumed as a root vegetable (hypocotyl plus true root), a leafy vegetable, sprouts, seeds or as seed pods and is also used as cover crop or forage crop. Cultivated radish may have experienced multiple domestication events. Consumer preferences are regionally based, resulting in morphological diversity combined with adaptation to local conditions. Economically, the crop is highly valuable and represents 2% of total vegetable production (7 million tons/year) in the world. In human diets, radish provides a rich source of vitamin A, vitamin C, minerals and carbohydrates. Breeding improvement has focused on size and shape. A Plant Genetic Resources Unit (PGRU) radish core set was assembled based on weighted geographical sampling from the germplasm collection. This resulted in 152 accessions representing 35 countries. From this core set, DNA from each of five plants per accession was isolated and genotyped using genotyping by sequencing (GBS). GBS libraries were constructed using the restriction enzyme PstI with standard barcode and common adapter sets, and assayed on a Genome Analyzer II. Output files were analyzed using the TASSEL5 pipeline and GenBank assembly accession GCA_002197605.1, *Raphanus sativus* cultivar XYB36-2 as a reference genome. After quality filtering, 52,643 SNPs were retained for downstream analysis of genetic diversity and population structure. These results have provided improved resolution of genetic relationships within and among accessions and geographical regions. Understanding such relationships will inform the continued germplasm conservation and genetic improvement of this important crop.

Specified Source(s) of Funding: USDA-ARS Plant Genetic Resources Unit

Accuracy of Genomic Prediction Approaches for Enhancing Resistance to Phytophthora Crown Rot in Strawberry *(Poster Board #223)*

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Phytophthora crown rot, a soil-borne disease caused by the oomycete pathogen *Phytophthora cactorum*, damages the roots and crowns of strawberry (*Fragaria x ananassa*) plants. This disease is especially prevalent and problematic in heavy and wet soils and has been a persistent problem in strawberry production. Soil fumigation has previously been widely used to suppress this pathogen. Earlier studies have indicated that the genetics of resistance to this pathogen are complex with heritabilities in the 30-50% range, although one or two large-effect loci have been reported in certain populations. Here, we report the results of a genome-wide study of the genetics of Phytophthora crown rot resistance in octoploid strawberry. We developed a training population comprised of over 400 germplasm accessions including heirloom and modern cultivars that sample demographic and phenotypic diversity worldwide. The training population was genotyped with a 49,000-SNP genotyping array and phenotyped for resistance to Phytophthora crown rot in 2017-18 and 2018-19 replicated field experiments. Plants were artificially inoculated and grown in soils that had been fumigated to eliminate the confounding effects of other soil-borne pathogens. We observed a normal distribution among individuals in the training population, with phenotypes spanning the range from highly resistant to highly susceptible. The broad-sense heritability of resistance was 0.5. We did not observe the segregation of large effect loci in the genome-wide association study. The accuracy of genomic predictions suggests that breeding for resistance to this

An asterisk (*) in front of a name indicates the presenting author.

pathogen can be enhanced by using whole-genome regression and similar approaches.

Fruit Characterization of Ecuadorian *Prunus Serotina* subsp. Capuli *(Poster Board #224)*

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Prunus serotina (black cherry) is native to America and consists of five subspecies. Black cherry trees are found in forests throughout the U.S. and are known for their high-quality wood. Their fruits are small, with high astringency, making them unsuitable for human consumption. One of the *P. serotina* subspecies, known as subsp. capuli, is endemic to Ecuador and is characterized by larger, juicer, and tastier fruit. They have important nutraceutical values and are available in the Ecuadorian market. However, no commercial varieties of capulies are currently available. In 2016, 45 accessions (genotypes) of capulies collected from three main provinces in Ecuador were characterized for fruit weight and shape, endocarp weight and shape, and °brix. The weight of three replicates of 10 fruits and 10 endocarps of each accession were measured. Diameter and height for five fruits and five endocarps of each accession were measured. °Brix for five individual fruit representatives of each accession were also quantified using a handheld refractometer. The accession PserTU48 had the largest average weight of 4.4 g per fruit and PserCH90 had the smallest average weight of 0.7 g per fruit. PserTU77 had the largest endocarp with an average 0.48 g per fruit and PserCH90 had the smallest with an average 0.17 g per fruit. °Brix was found to be the highest for PserCH112 (30.1) and lowest for PserCH113 (14.4). Strong correlations were observed between fruit and endocarp for weight (r=0.78, P<0.001), diameter (r=0.78, P<0.001) and height (r= 0.79, P<0.001). °Brix was independent of fruit and endocarp height, diameter and weight. This research is an important first step towards determining capuli's potential and adaptability to the Southeastern U.S. and selection of valuable genotypes with commercial characteristics to lay the foundations of their breeding program.

Developmental Mutants of a Diploid Strawberry, *Fragaria vesca* *(Poster Board #225)*

Janet Slovin*, USDA/ARS

The cultivated strawberry, *Fragaria* x*ananassa*, is a valuable perennial crop with a recently published genome sequence. Molecular research has focused on fruit development, primarily with respect to ripening and fruit quality, or resistance to disease, however, little is known about the molecular physiology of plant growth and development. *F.* x*ananassa* is octoploid, so one of the diploid progenitors, the woodland strawberry *F. vesca*, was developed as a model system for strawberry. A high quality PacBio genome sequence of *F. vesca* is published, several inbred lines of this small plant are available, and *F. vesca* is transformable with *Agrobacterium*. Chemically induced mutants of *F. vesca* have been described, and CRISPR technology has been successfully applied this plant. To increase the utility of *F. vesca*, EMS treatment of imbibed seed was used to induce mutations in the runnering inbred line, Hawaii 4F7-3 (PI664444), the line used for sequencing. Resulting M2 seedlings and plants were scored for plant size and architecture, leaf color, texture and shape, flowering and flower morphology, ability to produce fruit, and fruit shape and size. Plants with mutations affecting runnering and crown architecture, fruit shape, and sexual reproductive development have been further analyzed. H4EMS703 is non-runnering, however the sequences of *FveGa20ox4* and *FveRGA1 DELLA*, two genes reported as regulating runnering, are wild-type. Gene expression and bulked segregant analysis are underway with this mutant. The fruit of H4EMS065 appear long and slender. Morphological analysis indicates that H4EMS065 fruit are not longer than wild-type, but are significantly more slender. The genetics of this mutation, and that of H4EMS068, which has severely short inflorescences are being investigated. In preliminary experiments, both mutations appear result from a single recessive mutation. Six mutants exhibiting various degrees of decreased, or even no fruit production (the fertilized pistil called an achene) are being characterized for pollen development as well as the ability to form fruit when fertilized with wild-type pollen.

Genetic Diversity of Muscadine Grapes (*Vitis rotundifolia*) Using SSR Markers *(Poster Board #226)*

Shanshan Cao, The University of Georgia and Patrick J Conner*, University of Georgia

Muscadine grape (*Vitis rotundifolia*) was the first native North American grape to be domesticated. Over the last century breeding programs have created a large collection of muscadine cultivars. In this study, simple sequence repeat (SSR) markers were used to access the genetic diversity of muscadines. With 20 SSR markers, a total of 161 alleles were amplified for 71 muscadine cultivars producing an average of 8.1 alleles per marker. The analysis of genetic diversity was conducted at four levels: all muscadine cultivars, historical muscadine cultivars, current muscadine cultivars and wild relative accessions. While sharing the similar average *Ho* (observed heterozygosity), both the average alleles per marker and the number of private alleles (alleles detected only in the group) for wild muscadines (8.4 and 65) were higher than that for cultivated muscadines (8.1 and 58). It indicated that eight wild muscadines convey a higher level of genetic diversity than 71 cultivated muscadines. Although elite cultivars tend to be used excessively in recent muscadine breeding programs, the data proved the set of current cultivars also has substantial diversity and there is no inbreeding depression observed. The Principle Coordinate Analysis (PCoA) shows clear separation among wild accessions, *Vitis* cultivars, and cultivated muscadines with

PCoA1 and PCoA2 explaining 11.1% and 9.3% of the total variation respectively.

Specified Source(s) of Funding: Southern Region Small Fruit Consortium

Development of a GBS-Based Genetic Linkage Map in *Malus Domestica* 'Royal Gala' × *Malus Sieversii* Populations *(Poster Board #227)*

Jie Arro*; Chihcheng T. Chao; Benjamin Gutierrez and Gennaro Fazio, USDA-ARS Plant Genetic Resources Unit

We report the development of a high-density linkage map for interspecific *Malus* hybrids based on GBS markers obtained from cross between *Malus domestica* cultivar 'Royal Gala' and seven *Malus sieversii* accessions as male parents. These populations were used in prior genetic studies of fruit acidity and blue mold resistance. A total of 1,251 progeny among the seven half-sib families yielded 476,000 markers, of which an average 1,799 markers were placed into 17 linkage groups. Separated into pseudo-testcross maps, the average length of was 1420cM and 2178cM, or about 0.48 and 1.1 cM/marker for the 'Royal Gala' and *M. sieversii* maps, respectively. Using this map, we detected major QTLs for two segregating traits among the half-sib families. Burrknot, a pervasive physiological disorder which weakens the trunk and is an entry point for pathogens, segregate in the 'Royal Gala' background at LG 11. Likewise, a putative resistance to leafspot-like disease incidence observed in 2017, is strongly associated in the 'Royal Gala' background at LG 10. These results provide useful foundations in dissecting the genetic architecture and feasibility of selective breeding for other novel traits in apple.

Specified Source(s) of Funding: USDA-ARS Plant Genetic Resources Unit

Novel Dominant Genes Conferring Resistance to Fusarium Wilt Are Uncovered in Heirloom Cultivars of Strawberry *(Poster Board #228)*

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For over 50 years soil fumigation with methyl bromide was a common practice used to suppress soil-borne pathogen populations in strawberry until its complete ban in 2016. The efficacy of alternative chemicals for soil fumigation appears to be significantly lower than methyl bromide, which greatly increases the risk of yield losses caused by soil-borne pathogens. *Fusarium oxysporum* f. sp. *fragariae*, the pathogen that causes Fusarium wilt, has emerged as one of the most problematic and widespread soil-borne pathogens in organic and post-methyl bromide production systems. We previously described a dominant gene (*Fw1*) that confers resistance to Fusarium wilt. The most predictive SNP (AX-166521396) associated with the resistant *Fw1* allele, had a frequency of 0.18 in the UC Davis germplasm collection. AX-166521396 accurately predicted Fusarium wilt resistance phenotypes in 97.3% of the germplasm collection. Three heirloom cultivars (Wiltguard, Guardian, and Earliglow) identified in the previous study were resistant to Fusarium wilt but shared the DNA marker haplotype associated with the susceptible allele (*fw1*). We hypothesized that these cultivars carry novel *R*-genes. To explore this further, we phenotyped segregating populations developed by self-pollinating Earliglow, Wiltguard, and Guardian. Two of these populations segregated for resistance to Fusarium wilt and were genotyped with a 49,000-SNP genotyping array—the Earliglow population was completely resistant. Here, we show that Wiltguard and Guardian carry novel dominant *R*-genes. Guardian carries *Fw2 which* mapped to chromosome 2-4 in close proximity to *Fw1*. Mapping of *Fw3* in Wiltguard is underway. We developed sub-genome specific SNP markers to accelerate the introduction of *R*-genes from these heirloom cultivars into modern cultivars through marker-assisted selection.

Genetic Diversity and Relationship of Wild *Kalmia Latifolia* l. in the Eastern United States Using ISSR Markers *(Poster Board #229)*

He Li[1]; Matthew Chappell[2] and Donglin Zhang*[2], (1)Central South University of Forestry and Technology, (2)University of Georgia

Kalmia latifoliaL. (mountain laurel), an attractive flowering shrub, is considered to be a great ornamental plant for the eastern U.S. Wild plant resources have been historically involved in breeding programs to develop elite cultivars, however limited information on genetic diversity and relationship of wild mountain laurel would be an obstacle. Genetic diversity among and within eight mountain laurel populations and genetic relationship among 48 wild accessions sampled from eight populations were assessed. All accessions were analyzed using eight Inter Simple Sequence Repeat (ISSR) markers. A total of 116 bands were amplified, 90.52% of which (105) were polymorphic. The relatively low proportion of total genetic diversity among populations (G_{ST}=0.38) corresponding with the low percentage of variation among populations from AMOVA (30%) indicated that individual plants within populations were likely to be genetically different, but each population contained a similar complement of alleles in similar frequencies. A relatively large proportion of diversity was attributed to within-population variation, yet the low actual diversity within populations (H_S=0.19) was observed due to the small geographic size of populations and the ability of self of mountain laurel. Nei's unbiased genetic identity indicated the higher genetic similarity between geographically closed populations (0.8994-0.9169) compared with that between geographically isolated populations (0.8024-0.8913). Correspondingly, UPGMA dendrogram exhibited the clustering of nearby populations and four clusters correlated with geographic

An asterisk (*) in front of a name indicates the presenting author.

regions. The overall results would benefit breeding of mountain laurel on collecting wild resources, selecting parents, and increasing genetic diversity.

Specified Source(s) of Funding: Grant from University of Georgia Research Foundation.

Plant Biotechnology 2 (Poster)

Development and Characterization of EST-SSR Markers from Balsam Fir (Abies balsamea, L.) Transcriptome and Genetic Conformity Studies in Somatic Embryogenic Lines *(Poster Board #189)*

Sherin Jose; Jane Blackburn and Rajasekaran R. Lada*, Faculty of Agriculture, Dalhousie University

Balsam fir (Abies balsamea L.) the principal Christmas tree species, shapes eastern Canada's Christmas tree and greenery industries due to its unique qualities such as fragrance, color and tree architecture. Improving postharvest needle retention has been an economically important attribute in this species. However, revealing the genetic basis of needle retention and high throughput genotyping of balsam fir lines having valuable economic traits have been hindered by limited genomic resources. A balsam fir transcriptome was constructed from six lines with variability in needle retention and was used to generate simple sequence repeat (SSR) markers. Transcriptome was generated via paired-end Illumina HiSeq 2000 platform and resulted in 30,647 unigenes. A SSR search of the transcriptome identified 2144 SSRs, including 2081 perfect (di- 122; tri- 930; tetra- 217; penta- 90 and hexa- 852) and 63 compound SSRs. The transcriptome dataset provides a valuable resource for future genetic and genomic studies in balsam fir.

A growing demand for high needle retaining balsam fir clones with industrial interest reinforces the need to establish clonal propagation via somatic embryogenesis and preservation of high value genotypes that retain traits of interest. Towards this end, a successful protocol of somatic embryogenesis (SE) and cryopreservation of embryogenic tissue has been established for high quality balsam fir hybrids. However, prolonged maintenance of tissues in cultures reduces its embryogenic potential and increases the chances of genetic instability. In the present study, genetic stability of balsam fir embryogenic cell lines (ECLs) was evaluated with the aid of SSR markers developed from transcriptome data. Sixty-five primer pairs were randomly selected and screened for identifying their utility in differentiating somaclones. Out of the 65 SSR primers analysed, 7 shown polymorphic banding pattern between the selected parental clones. A total of 53 ECLs developed from immature zygotic embryos of balsam fir collected from 8 full-sib families were subjected to genetic conformity studies using microsatellite marker assay. The analysis was performed on proliferating callus, mature somatic embryos and regenerated seedlings and compared with that of parental genotypes. In addition, the effect of overall SE process was also assessed through the analysis of genetic stability in somatic embryos regenerated from cryopreserved calluses. The results of the study demonstrated that clonal propagation of elite balsam fir lines using SE can be carried out with a low risk of genetic instability and the use of SSR marker system to successfully assess genetic variations within balsam fir lines.

Keywords: *Abies balsamea*, Christmas tree, transcriptomics, SSR, somatic embryogenesis, clonal fidelity

Specified Source(s) of Funding: Atlantic Canada Opportunities Agency (ACOA)

Production and Molecular Characterization of New Mandarin Hybrids for Fruit Quality Improvement *(Poster Board #190)*

Ahmad A. Omar*; Azza Mohamed and Jude W. Grosser, University of Florida

Somatic hybridization (protoplast fusion) has become an essential part of citrus breeding programs worldwide that helps to generate new somatic hybrids or cybrids by mixing desired traits from different parents including tolerance to abiotic and biotic stresses as well as fruit quality. In theory, it allows to combine into the same cell not only the nuclear genome of one parent, but also the cytoplasm genome of the second by producing new cytoplasmic-nuclear genome combinations at both ploidy levels (diploid and tetraploid) to enhances the diversity of gene pools in the new germplasm. Fruit quality is substantially one of the most important goals for any citrus breeding program. There are diversity of plant material extends great predictions for variety improvement, mainly for the development of new scions and rootstocks. However, *Citrus* is characterized by a complex reproductive system, which limits the possibilities of conventional breeding. In this study, protoplast fusion experiments were performed between 'W. Murcott' (Afourer) mandarin (a hybrid of 'Murcott' mandarin and unknown pollen parent) as an embryogenic cell suspension source for embryogenic protoplasts and five different mesophyll sources of protoplasts ('Sugar Bell', 'Fallglo', 'Lb8-8', 'Bingo', and '7-11' new mandarin). To characterize regenerated plants, the regenerated plantlets were subjected to flow cytometry (FCM) to determine the ploidy level. After generating the plants, genomic DNA was extracted for molecular investigation of genomic constitutions using simple sequence repeats (SSR) markers, universal chloroplast (cp) and mitochondrial (mt) PCR markers. Ploidy analysis using flow cytometry has shown so far that 114 of the 118 regenerated plants were diploid, while two, which originated from 'W. Murcott' + 'Sugar Belle'; one, which generated from 'W. Murcott' + 'Fallglo' and one, which originated 'W. Murcott' + '7-11' were tetraploids. The nuclear SSR, cp and mt markers are underway to confirm the genetic background of the regenerated somatic hybrids and cybrids plants.

Development of Multiplex PCR for Diagnosis of Five Potexviruses in Cactus Plant *(Poster Board #191)*

Eun Gyeong Song*; Chung Hwa Park; Yoon Hyun Bang; Hae Min Lee and Ki Hyun Ryu, Seoul Women's University

Five potexviruses, namely cactus virus X, opuntia virus X, pitaya virus X, schlumbergera virus X, and zygocactus virus X, have been reported in cactus plants. Here, a multiplex PCR based on specific DPO primers was developed to simultaneously detect these five viruses and an internal control in 18 field samples consisting of 16 cactus species. Viruses were detected in nine of the 18 cactus samples. Cactus virus X, pitaya virus X, schlumbergera virus X, and zygocactus virus X were simultaneously detected in *Aporocactus flagelliformis* and *Notocactus leninghausii* f. *cristatus*. Our multiplex PCR was applied successfully in the field samples and it could be useful in diagnosis of virus infection in cactus plants.

Specified Source(s) of Funding: This work was supported in part by the National Research Foundation in Korea (grant numbers 2014M3A9B8022821, 2018R1D1A1B07045964).

Development of Variegated Lettuce Using CRISPR/Cas9 Technology *(Poster Board #192)*

Chi Dinh Nguyen*[1]; Juncheng Li[2] and Heqiang Huo[2], (1) University of Florida/IFAS, (2)University of Florida

The need for gene edited plants to combat issues of growing population rate, extreme weather, and reduced agricultural land availability is more evident than ever as growers are struggling to adapt to the changing environment. The clustered, regularly interspaced, short palindromic repeat (CRISPR)-CRISPR associated endonuclease 9 (CRISPR/Cas9) system has emerged as a powerful approach for precision breeding to create plants with desirable traits. However, gene editing efficiency of CRISPR/Cas9 in plant relies on the efficacy of generating transgenic plant or tissues with high expression of Cas9 endonuclease. Here, we have constructed a CRISPR-Cas9 vector containing a fused NPT-GFP for high-efficiency gene-editing in annual flowering plants. The high expression of GFP during plant regeneration allowed us to minimize the positional effect on T-DNA expression and preferentially select transgenic seedlings with high expression of Cas9. With this construct, we have targeted the variegation gene *LsVar2* in lettuce. Forty independent lines were generated, 27 of which showed strong GFP signals. None of transgenic lines with no GFP signals, although these lines carried T-DNA insertions, exhibited phenotypic difference in leaves compared to the control lines, indicating that GFP signal is at least partially associated with the gene editing events. Six of 27 T0 transgenic lines with GFP signals exhibited variegated leaves. Albino seedlings were observed in segregated progenies of these variegated lines, and sequencing results revealed that homozygous mutations created by Cas9 editing occurred to all these albino seedlings. By contrast, heterozygous mutations were only identified in the plants with variegated leaves and significantly reduced chlorophyll content, and these plants were able to grow and mature normally. Therefore, in addition to confirming the efficiency of the CRISPR-Cas9 vector, our data also provide a proof-of-concept for targeting VAR2 gene in ornamental plants where variegation phenotype is highly favorable. In conclusion, the unique designing of our CRISPR/Cas9 construct allow us to improve gene-editing efficiency and efficiently screen non-TDNA mutants through detecting GFP signals during plant regeneration and progeny segregation.

The Salicylic Acid Binding Protein 2 from *Nicotiana Tabacum* (NtSABP2) Can Enhance the Plant Defense Related Pathways When Overexpressed in Sweet Orange *(Poster Board #194)*

Juliana M Soares; Wenming Qiu; Jude W. Grosser and Manjul Dutt*, University of Florida

Huanglongbing (HLB) or "citrus greening" is the most devastating disease ever encountered by citrus growers. The bacteria colonize phloem of the trees resulting in an uneven blotchy mottle symptom in the leaves, aborted seeds and production of salty and bitter fruits. Because of its potential of destruction, the most desirable form of long-term management for HLB is the use of genetic resistance. The expression of transgenes involved with plant defense activation pathways is an effective approach to increase tolerance to HLB. The SALICYLIC ACID BINDING PROTEIN 2 (SABP2), an enzyme that mediates the conversion of methyl salicylic acid into salicylic acid, is a well-known signal involved with the activation of plant defense. To obtain durable HLB tolerance in the otherwise susceptible sweet orange, transgenic trees were produced that overexpressed the *Nicotiana tabacum* SABP2 (*Nt*SABP2). These sweet orange (cvs. 'Hamlin' and 'Valencia') were produced to express the *Nt*SABP2 gene, either under the control of a constitutive CaMV 35S promoter (35S-SABP2) or a phloem specific *Arabidopsis thaliana SUC2* promoter (*At*SUC2-SABP2). The transcript and protein analysis of transgenics assayed by qPCR and western blot enabled the selection of eleven lines. Plant defense related gene expression assay revealed an increase in *PR-2* but not of *PR-1*. The transgenic lines with the highest SABP2 transgene expression also had the highest accumulation of *PR-2*. All transgenic lines were planted in our USDA approved transgenic field site. Under field conditions, two of the 35S-SABP2 lines and one of the *At*SUC2-SABP2 line had enhanced tolerance to HLB, remaining PCR negative even after several years in the field. Altogether, the results indicate that *Nt*SABP2 expressed either constitutively or in the phloem tissues can confer tolerance to HLB. The increase in resistance might be mediated by the activation of plant defense pathways, however, the specific pathway and biochemical mechanism orchestrating this process remain to be investigated.

Plant Growth Regulation (Poster)

Drought Tolerance and Rooting in Grape Cuttings Under Dehydration Conditions Is Affected By Inhibitor of ABA8'-Hydroxylase *(Poster Board #407)*

Hiroyuki Tomiyama*, Chiba university

The effects of abscisic acid (ABA) 8'-hydroxylase inhibitor (Abz-E3M) on drought tolerance and rooting in grape cuttings under dehydration condition were examined. Water potential, proline concentration, antioxidant activity, and endogenous ABA and ABA metabolites (phaseic acid and dihydrophaseic acid) in leaves and percentage of rooted cuttings and endogenous indole-3-acetic acid (IAA) in basal point of cuttings were analyzed. Endogenous ABA in Abz-E3M group was higher than those in control group at 4 days after treatment and ABA metabolites significantly decreased in Abz-E3M group compared to the control group. Water potential in Abz-E3M group was higher than that in the control group among the experiment. Proline concentrations and antioxidant activity in Abz-E3M group were lower than those in the control group under dehydration stress. The percentage of rooted cuttings in Abz-E3M group was higher than that in the control group significantly at 8 days after treatment and endogenous IAA in Abz-E3M group was higher than that in the control group at 4 days after treatment. Theses results suggest that Abz-E3M enhanced drought tolerance and percentage of rooted cuttings in grapes under dehydration condition by regulating phytohormone.

Effect of Enhanced Dissolved Oxygen and LED Lighting on Growth and Development of Hydroponically Grown Crown Peas *(Poster Board #408)*

Sonja Maki* and Taylor North, University of Wisconsin-River Falls

Crown pea plants (*Pisum sativum* L.) have determinate growth and also develop an enlarged meristem due to a mutation in a gene that leads to a fasciated phenotype. As a result, crown peas produce numerous flowers on a widened apex. In the current study, we used the crown pea to investigate the effect of enhanced dissolved oxygen and supplemental LED lighting on growth and development of plants grown in a nutrient film technique (NFT) hydroponic system. A 1:1 mix of blue and red LED light units (Phillips) and an electrolysis system (O2Grow) were used to provide the following treatments to supplement standard NFT conditions: 1) Red/Blue LED supplemental lighting; 2) Red/Blue LED lights and enhanced dissolved oxygen (DO); 3) enhanced DO; and 4) control (nutrient solution alone). Overall, plant growth was greatest in the enhanced dissolved oxygen environments. Crown pea plants were taller, branched more, produced nodes faster and had wider apices and more root mass than the control plants and control plants + LED lights. Root growth was also greatest in the enhanced DO + LED light environment. However, the node of flower initiation was highest in the enhanced DO environments (treatments 2 and 3) indicating a delay in flowering. Enhancing the dissolved oxygen content and light environment in NFT hydroponic systems warrants further investigation to determine the effects on plant growth and reproductive development in the crown pea.

Specified Source(s) of Funding: University of Wisconsin-River Falls USE Grant

Exploring the Use of Seaweed Biostimulant in Organic Strawberry Production *(Poster Board #409)*

Jianyu Li*; Xin Zhao; Bodh R. Paudel and Zack Black, University of Florida

Interest in organic strawberry production is increasing among growers in Florida, while more up-to-date research-based information is needed to help address plant nutrient management challenges in organic systems. Many studies have investigated the beneficial effects of application of seaweed extracts on horticultural crops including nutrient uptake and yield enhancement, improved plant growth performance, and tolerance to biotic and abiotic stresses. Although seaweed extract biostimulant has been suggested to play a role in enhancing root growth and plant nutrient uptake in organic farming, little information is available with respect to the use of seaweed extract biostimulants in organic strawberry production systems. In this preliminary study, the impacts of Stimplex® on Sweet Sensation® 'Florida127' strawberry plant growth and yield performance were assessed during the 2017-2018 season at the University of Florida Plant Science Research and Education Unit in Citra, FL. Stimplex® containing cytokinin is a commercial liquid seaweed extract biostimulant derived from *Ascophyllum nodosum*. The field experiment was arranged in a split-split plot design with 4 replications. The combinations of cover crop (sunn hemp or weedy fallow) and compost (no compost, 22.4 t/ha or 44.8 t/ha) treatments were randomized in the whole plots and the fertilization treatments were included in the subplots. The fertilization treatments consisted of preplant fertilizer application at 84.1 kg/ha N, in-season fertigation at 328.7 kg/ha N, a combination of both, and no fertilizer control. Stimplex® treatments in the sub-subplots included biweekly root application of Stimplex® at 4.7 L/ha and no Stimplex® control. Strawberry tray plugs were transplanted in Oct. 2017 and fruit were harvested from Dec. 2017 to Apr. 2018. Results indicated that application of Stimplex® didn't significantly enhance aboveground N accumulation based on plant tissue N analysis and aboveground biomass at the end of the strawberry season. Strawberry plant growth parameters including leaf area, crown number and crown diameter were not significantly affected by Stimplex® during the season. However, Stimplex® application resulted in significantly higher marketable fruit number and weight than the control in December, January, February, and

March. The whole-season marketable fruit yield of the Stimplex® treatment was also significantly improved compared to the control. There were not significant interaction effects between Stimplex® and other experimental factors including cover crop, compost, and fertilization. More studies involving different strawberry cultivars over multiple seasons are needed to further assess the beneficial effects of seaweed extract biostimulants in organic strawberry production systems as well as the underlying mechanisms.

Specified Source(s) of Funding: USDA OREI

Physiochemical Influence of Growth Retardant Prohexadione-Calcium on Sweet Potato (*Ipomea batatas*) Under Field Conditions *(Poster Board #410)*

Batey Lydia; Ananda Nanjundaswamy and Victor Njiti*, Alcorn State University

Reducing shoot growth has many biological importance in plants. Shoot growth retardation increases source to sink ratio. The decreased shoot biomass concomitantly increase photosynthates to move towards roots in some plants. Many new generation gibberellin biosynthetic inhibitors like Apogee (which contains 27.5% prohexadione-calcium) known to exhibit shoot reduction and has been used in reducing shoot growth of horticultural crops such as apples. The overall objective of the study was to evaluate the impact of field application of Apogee on sweet potato. Two popular varieties of sweet potatoes, O'Henry and Beauregard were planted in field conditions in Alcorn State Experiment Station under completely randomized block design. Root and Shoot samples were collected at 30 days after panting, 60 days after panting and at harvest. Samples were analyzed for total phenolics, Chlorgeneic acid and β-Carotene. Our results indicate that Apogee did not significantly influence the level of most secondarily metabolites. This indicate that the secondary metabolites synthesis is not influenced by growth retardant in sweet potato. The presentation will deal with impact of Apogee on the secondary metabolites such as carotene and phenolic compounds will be discussed.

Specified Source(s) of Funding: USDA/NIFA, Alcorn State University

Interaction of the Plant Growth Regulator, AVG, with Varying Nitrogen Application Rates in Relation to Yield and Quality in Almonds *(Poster Board #411)*

Travis Woods*, California State University and Gureet Brar, California State University Fresno

Almond kernels are large nitrogen sinks throughout the growing season. It has been shown that in order to meet their nitrogen demands, developing kernels will compete with adjacent leaves for nitrogen, reducing leaf nitrogen content, and thus reducing leaf photosynthetic capacity, creating a resource deficit. This resource deficit results in 'June Drop'. Reports also suggest that application of aminoethoxyvinylglycine hydrochloride (AVG), an ethylene biosynthesis inhibitor, increases fruit set. However, studies have shown that an AVG induced increased nut set was followed by an increased 'June Drop'. The current study was aimed at studying the interaction of supplemental nitrogen with AVG application for enhanced nut set and fruit retention. Fourteen-year-old almond trees of cvs. 'Butte' and 'Padre' were selected in an orchard in Biola, CA. The experiment was designed as a full factorial with three levels of nitrogen: N1: Grower standard (GS); N2: GS+12%, and N3: GS+25%; and two levels of AVG: 'AVG' and 'no AVG', 6 treatments in total. Data were taken on blossom number, nut set percent, June Drop percent, yield, chlorophyll content and fruit N content. Treatments with AVG application showed significant differences in nut set in comparison with control. However, data on yield and June drop didn't show any significant differences. The nuts from the AVG application treatments had significantly higher number of double kernels with 15.2, 12.6 and 14.2 percent in N1, N2 and N3, respectively, while 'no AVG' treatments had 4.8, 3.4, and 5.2 percent double kernels, respectively.

Specified Source(s) of Funding: Valent USA

Effect of Vermicast and Rock Powder Treatment on Plant Rooting *(Poster Board #412)*

Qihuan Zhou; Lokanadha R. Gunupuru; Samuel K. Asiedu* and Lord Abbey, Dalhousie University, Faculty of Agriculture

Vermicast and rock powder are common natural growing medium amendments that promote plant growth, but their specific effect on root cuttings is understudied. This experiment was performed to investigate the effects of vermicast and rock powder pretreatment on the rate of rooting in different plant species. The experimental treatments (1) 10 g of vermicast+15 g of rock powder; (2) 10 g of vermicast alone; (3) 15 g of rock powder alone; and (4) distilled water as a blank control were applied on three different plant species, namely; tiger nut (*Cyperus rotundus*), Jamaican thyme (*Plectranthus amboinicus*) and Malabar spinach (*Basella alba*). The different plant species responded differently to the vermicast versus rock powder and their combination. The rock powder had the highest effect on Malabar spinach root length of 46.7 cm at week 5 after planting followed by 39.6 cm for plants grown in the combination of vermicast and rock powder. The response of the Jamaican thyme roots to water treatment was 43% more compared to vermicast. Jamaican thyme plants grown in the combined treatment had the least response, which was about 59% less compared to the water treatment. The enhancement of root growth by rock powder and water was similar at 16 cm at the end of week 5 of the experiment. The combined vermicast and rock powder performed well on tiger nut up to week 3 when it remained relatively constant just like the vermicast treatment. However, the vermicast treatment had a consistently least effect of 4.4 cm tiger nut plant root length. In conclusion, rock powder can potentially be used as a root enhancer but further studies will be required prior to recommendation.

Key words: Vermicast, rock powder, *Basella alba*, *Cyperus rotundus*, *Plectranthus amboinicus*

Late Dormancy Application of Ethephon and GA3 Affect Bud Respiration and Bloom Uniformity in Pistachios *(Poster Board #413)*

Daniel YP Syverson*[1]; Gureet Brar[1]; Louise Ferguson[2] and Masood Khezri[3], (1)California State University Fresno, (2) University of California, Davis, (3)California State University

Pistachio yields in California have recently been harmed by low-chill winters. Low-chill winters can cause delayed and uneven dormancy release, asynchrony between male and female bloom, and greater exposure to late-season pest pressure from navel orangeworm. We tested putative dormancy-breaking agents (DBAs) for late-winter application to pistachio, hoping to advance or compress the bloom window without adverse yield effects. We compared ethephon, GA3, and AVG sprays near endodormancy completion with grower standard treatments of horticultural oil and water. In 2018, 0.2% GA3 advanced bloom by 5 +/- 1 days, and 500 ppm ethephon and 6% oil both advanced bloom by 2 +/- 1 days. GA3 additionally compressed the bloom window from 11 to 9 days by regularizing the differences between shoots with different facings. 125 ppm AVG did not advance bloom and may interfere with the accumulation of heat. DBAs' effects on bud respiration immediately after application were often different from their effects on the endogenous increase in respiration in the pre-bloom period. Some DBAs increased dormant bud respiration rates from ~7 to ~10 mg CO_2/(min-g FW), but these changes were overshadowed by endogenous pre-bloom bud respiration increases to ~50 mg CO_2/(min-g FW) or more. DBA enhancement of endogenous pre-bloom respiration concorded with DBA-induced bloom order; in contrast, DBA-induced increases of respiration immediately after application were uncorrelated with effects on bloom and should be considered a side effect unless part of a known mode of action. Planned analyses of non-structural carbohydrates will supplement respiration and phenology data to elucidate the interplay between energy stocks, energy consumption, and chemically assisted dormancy release in pistachio.

Specified Source(s) of Funding: California Pistachio Research Board

Pomology (Poster)

Effect of Retain(TM) on Floral Organs Longevity, Ethylene Production and Fruit Set of Olive Trees *(Poster Board #338)*

Fangyi Wang*; Leigh F Archer and Abdollatif Sheikhi, University of California, Davis

Fruit set is low in olives. Olives produce an abundant number of flowers, 10% to 25% of which remained after petal drop and set fruit. Major fruit drop occurs during the 5-7 weeks after full bloom, leaving a final fruit set of 1% to 2%. One hypothesis of low fruit set in olives is that the short life-span of olive flowers limits the stigma receptivity, ovule longevity, and effective pollination period (EPP). Ethylene is involved in multiple aspects of floral senescence an abscission. Amionoethoxyvinylglycine (AVG), an active ingredient of ReTain(TM), acts as an ethylene inhibitor. AVG competitively inhibit the activity of ACC (1-aminocyclopropanecarboxylate) synthase, which is a key enzyme in the ethylene biosynthesis pathway. The purpose of this study is to evaluate the effects of ReTain(TM) (AVG) application at bloom on flower ethylene production, flower longevity, fruit set, and yield of oil olive trees.

The Influence of Soil Treatments on Growth and Recovery of Olives *(Poster Board #339)*

Robert Lane* and Shyam Nair, Sam Houston State University

While olives are native to the warm, dry summers and mild, rainy winters of the Mediterranean region, they can be successfully grown in areas with mild winters in Texas. However, occurrence of frequent freezes can damage olive plants, most severely on young plants. An olive orchard was established at Sam Houston State University's Gibbs Ranch in March, 2016. Low temperatures encountered in January 2017 killed many of the recently established plants and severely damaged others. This study analyzed the effects of soil treatments on the growth of the surviving, but badly damaged, trees and the new, pot-grown trees used to replace those that died due to freeze damage.

Twenty-five olive trees planted in 2016 that survived the 2016-17 winter with minor freeze damage (*Old*) and twenty-five newly planted replacement trees (*New*) were selected. The following treatments were randomly assigned to the two classes of trees (Old and New) with five replications (individual trees) of each treatment.

- ***Control***
- ***Fert***: 16-6-12 and 20-20-20 Osmocote fertilizer
- ***Compost+BM***: Mushroom compost + Blood Meal
- ***Fert+AMF***: *Fert* + Mycorrhizae
- ***Compost+BM+AMF****:* Compost + BM + Mycorrhizae

Measurements of plant height and stem diameter were taken ten times from 6-3-17 to 10-7-17 at 14-day intervals on each of the 50 trees. Treatment effects were assessed using the Analysis of Variance (ANOVA) for Completely Randomized

Design. Stem diameter increases for both *Old* and *New* plants was greatest with the mushroom compost + blood meal treatment. The 16-6-12 plus Osmocote treatment provided the greatest increases in plant height for the old plants, but was similar to that of the control group.

Ethephon Applications between Anthesis and Petal Fall Increase Ethylene Production Rate and Fruitlet Abscission of 'Montmorency' Tart Cherries in Combination with High Temperature

(Poster Board #340)

Mohamed Ghorab[1]; Mokhles Elsysy[1]; Nikki Rothwell[1]; Todd C. Einhorn[1] and Margherita A. Germani[*2], (1)Michigan State University, (2)Alma Mater Studiorum University of Bologna

Ethylene is a gaseous plant hormone serving critical roles in many plant processes, including plant growth, development, plant resiliency to abiotic stress, pathogen infection, seed germination and fruit ripening. The commercial product ethephon is applied to *Prunus cerasus* 'Montmorency' tart cherry orchards to promote uniform fruit abscission and facilitate mechanical harvest operations. Ethephon releases ethylene during degradation. There is also a need to abscise flowers and/or young developing fruitlets on young 'Montmorency' trees in order to promote canopy development and, more recently, as a means to reduce increased spotted wing drosophila (SWD) pressure. We initiated a study to determine the potential of ethephon as a fruitlet abscission agent. Rates of 50, 100, 200 and 400 ppm were applied at individual phenology stages (either 'first white', 50% full bloom, full bloom, 'petal fall' or 'shuck split') and compared to a non-treated control and the ethylene inhibitor, aminoethoxyvinilglycine (AVG) as the commercial product, ReTain (133 ppm). The study was replicated at two sites, Traverse City and Clarksville, Michigan. Each treatment was applied to four or five single-tree replicates, depending on the site. Flowers and fruitlets were collected every two to three days for several weeks, beginning the day of application, weighed and placed in sealed tubes to capture headspace gas. A gas chromatograph was used to quantify ethylene. Ethylene production rate of flowers and fruit increased relative to ethephon rate (~25 times at 400 ppm compared to the non-treated control). Ethylene production remained higher for ~five days following applications, irrespective of application timing. Natural ethylene production rate was quite low and AVG practically eliminated ethylene production. The effect of ethephon on fruit abscission differed between sites. At Clarksville, only minor reductions in fruit set were observed and these were not significant, irrespective of application timing or rate. At Traverse City, rates of 200 and 400 ppm reduced fruit set to ~80% and 100% of the non-treated control, but only at the petal fall timing. Temperatures during the petal fall application exceeded 27°C. Based on these data and preliminary data from 2017, temperature plays a far greater role in ethylene induced abscission than the fruit developmental stage. Higher ethephon rates may be required when temperatures are below 27°C. AVG had no effect on fruit set. Despite the relatively low fruit set of Montmorency (~20%), natural ethylene production rate of flowers and fruitlets does not appear to limit fruit set.

Effect of Windbreaks in Chilling Hour Accumulation of Subtropical Peaches in Florida *(Poster Board #341)*

Dustin Huff[*1]; Jose X. Chaparro[1] and Ali Sarkhosh[2], (1) University of Florida, (2)Univeristy of Florida

Accumulation of adequate chilling hours in peach trees is essential for timing and promoting flower and vegetative bud growth. Reduced chilling leads to a prolonged and often later flowering period, and delayed vegetative growth. Developing a system to increase chill hour accumulation in subtropical regions would allow the expansion and sustainability of the peach producing industry. Tall windbreaks may delay the increase in canopy air temperature after sunrise by creating a shaded environment, for several additional hours per day. A large commercial peach orchard located in St. Lucie County, FL was chosen for the study. The orchard has established windbreaks of Eucalyptus ranging in the height of 40-50ft. on the East and West borders, and all rows are oriented North-South. 20 dataloggers measuring temperature and relative humidity were placed in the middle of the peach canopy on selected trees, with 8 located in the two rows next to the East windbreak, 8 in the two rows next to the West windbreak, and 4 control rows in the middle of the orchard. Data were analyzed for the period of 17 Nov, 2018 through 24 Jan, 2019, the results will be presented and discussed.

Evaluation of Plant Growth Regulators to Induce Uniform Flowering in Low-Chill Peach Cultivars

(Poster Board #342)

Bikash Adhikari[*], CREC - University of Florida/IFAS and Tripti Vashisth, University of Florida

Peach (Prunus persica L.) is a deciduous crop, commonly grown in temperate regions. Its cultivation and production are rapidly increasing in Florida as growers are looking for alternative tree fruit crops. Peach tree requires the temperature of less than 7.2^{0}C for chilling hour accumulation (required accumulation differs among varieties). It is critical for the peach to undergo dormancy (inhibition of cell proliferation and shoot growth) for onset of successful commercial and uniform fruit production for next season. Abscisic acid (ABA) plays an important role in regulation of bud dormancy. On the other hand, use of hydrogen cyanamide (HC), is well known to help in breaking bud dormancy under mild winter conditions. Therefore, main objective of this study is to evaluate the efficacy of exogenously applied ABA inducing dormancy, under low-chill conditions. Four treatments were evaluated on two peach cultivars, 'UFBest'

An asterisk (*) in front of a name indicates the presenting author.

and ‘UFSun’. The experiment was set up as completely randomized design (n=4). The four applied treatments were: Untreated control; ABA (500 ppm/tree, 2 application, made three weeks apart in November); HC (1.2%) applied in late December; ABA+HC. All the treatments included with 0.125% surfactant. Leaf emergence, swollen bud, bud break, and flower were counted at every 15 days interval. Interestingly, first application of ABA resulted in complete defoliation in both varieties. In both varieties, ABA resulted in delay in bud swelling and flowering by at least 15 days. Use of ABA with HC resulted in highest and uniform flowering than HC alone in UFBest cultivar. This effect is most likely due to the fact that, HC application resulted in abscission of buds at advanced stage however, pretreatment of ABA potentially induced dormancy thereby decelerating the bud advancement. These field results will be paralleled with in depth- transcriptomic and metabolic analysis to validate and explore dormancy induction and dormancy break in low-chill peaches with use of plant growth regulators.

Ppnac187 Enhances Lignin Synthesis in ‘Whangkeumbae’ Pear (*Pyrus pyrifolia*) ‘Hard-End’ Fruit *(Poster Board #343)*

Shaolan Yang*, Qingdao Agricultural University; Mingtong Li Sr., Qingdao Agricultrual University and Suping Zhou, Tennessee State University

***PpNAC187* enhances lignin synthesis in ‘Whangkeumbae’ pear (*Pyrus pyrifolia*) ‘hard-end’ fruit**

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[*]Authors to whom correspondence should be addressed; E-mail: zsuping@tnstate.edu (S.Z.) Abstract

A disorder in pears known as ‘hard-end’ fruit affects the appearance, edible quality, and market value of pear fruit. To explore the mechanism underlying the formation of hard-end, RNA-Seq was carried out on the calyx end of ‘Whangkeumbae’ pear fruit with and without the hard-end symptom. Results indicated that genes in the phenylpropanoid pathway affecting lignification were up-regulated in hard-end fruit. An analysis of differentially expressed genes (DEGs) identified three NAC transcription factors, and RT-qPCR analysis of PpNAC138, PpNAC186 and PpNAC187 confirmed that PpNAC187 gene expression was correlated with the hard-end disorder in pear fruit. A transient increase in PpNAC187 was observed in the calyx end of ‘Whangkeumbae’ fruit when they began to exhibit hard-end symptom. Concomitantly, a higher level of PpCCR transcripts was observed; which is a key gene in lignin biosynthesis. Notably, lignin content in the stem and leaf tissues of transgenic tobacco overexpressing PpNAC187 was significantly higher than in control plants transformed with an empty vector. Furthermore, transgenic tobacco overexpressing PpNAC187 had a larger number of xylem vessel elements. Collectively, the results of this study confirmed that PpNAC187 functions in inducing lignification in pear fruit during the development of the hard-end disorder.

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Multi-Year Experiments Indicate Good Efficacy of Metamitron As a Post-Bloom Thinner for Apple and Pear, Though in Some Instances Severe Thinning of Apple Was Observed *(Poster Board #344)*

Mokhles Elsysy*[1]; Philip Schwallier[1]; Andrew Hubbard[2] and Todd C. Einhorn[1], (1)Michigan State University, (2)Oregon State University

Metamitron is a relatively new postbloom thinning compound for pome fruit. Metamitron interferes with the Photosystem II (PS II) pathway of photosynthesis and, consequently, creates a carbohydrate deficit that leads to fruit abscission. Metamitron is commercially available in several countries as a pome fruit thinner under the trade-name Brevis but the compound is not registered in the US. We have evaluated the thinning efficacy of metamitron for ‘Bartlett’ pear over three consecutive years (2015-2017) in Oregon and for ‘Honeycrisp’ and ‘Gala’ apple (2017 and 2018) in Michigan. Irrespective of the species (or cultivar in the case of apple), metamitron markedly reduced photosynthesis (PN) compared to non-treated controls, typically for a duration of two weeks, though in some cases the effect persisted for 25 days after application. Photosynthesis decreased linearly with increasing metamitron rate for pear but not apple. Pear fruit set was negatively, linearly related to metamitron rate. Apple fruit set was inconsistent between years for a given rate. High temperatures the preceding and subsequent days from application were associated with severe apple thinning in 2018. Application timings ranged between 6 and 16 mm fruit diameter depending on the year and species. For apple, timing had only a mild effect on thinning, with a slightly stronger response at delayed timings. For pear, early timings had little effect on thinning. The most efficacious rate for ‘Bartlett’ pear was between 200 and 300 ppm. More work is required to optimize rates for apple. In both crops, fruit size and quality was related to crop load and was significantly improved for metamitron treatments. Phytotoxicity (leaf burning and yellowing) was observed for apple when rates exceeded 400 ppm. Pear leaves displayed insignificant levels of phytotoxicity despite rates of 600 ppm. Future work is needed to evaluate the effect of surfactants, humidity and temperature on the absorption characteristics

of apple leaves.

Enhancing ‘Fuji’ Apple Red Fruit Color with Reflective Fabrics *(Poster Board #345)*

Thomas M. Kon*, North Carolina State University and Christopher D. Clavet, NC State University

For some apple cultivars, inadequate red fruit color development can reduce crop value. We evaluated the effects of reflective groundcovers on light interception and reflectance, yield, and fruit quality of ‘Fuji’ apple in 2018. An experiment was conducted in a mature ‘Fugachee Fuji’/‘G.11’ planted at 2.1 x 4.3 m spacing at a commercial orchard in Edneyville, NC. Multiple reflective groundcovers were evaluated and installed five weeks before anticipated harvest. Woven reflective groundcovers (Beltech PD-2911 and Extenday™; 3.5 m width) were placed adjacent to 7-tree plots (15.2 m long section) on each side of the row. Mylar reflective groundcover (1.0 m width) was placed adjacent to 7-tree plots on each side of the row and positioned proximal to the drip line. The experiment consisted of four treatments with six replications arranged in a randomized complete block design. Tukey’s honest significance test was used to test mean separation among treatments at $P = 0.05$. When compared to the control, woven groundcovers (Beltech PD-2911 and Extenday™) significantly increased PAR reflected from the groundcover on the north and south side of the trees. UV radiation reflected from Extenday™ was 20.7 times greater than the control on the north side of the tree and 18.9 times greater on the south side. Mylar did not affect UV radiation reflection on the north side of the tree, but increased UV reflected radiation on the south side of the tree when compared to the control. UV radiation levels of Beltech PD-2911 did not differ from the control in any canopy position. Extenday™ was effective in increasing light reflectance of PAR and UV light in the orchard canopy resulted in a significant increase in the proportion of fruit with greater than 50% red fruit color. Beltech PD-2911 increased PAR reflectance into the canopy, but UV light reflectance (250 to 400 nm) and the proportion of fruit with greater than 50% red fruit color did not differ from the untreated control. Reflective groundcovers did not influence fruit maturity indices or sunburn incidence.

Salt Tolerance in Apple Rootstocks *(Poster Board #346)*

Samuel Johnson*[1]; Teryl Roper[2]; Brent L Black[2]; Gennaro Fazio[3] and Grant Cardon[2], (1)1860, (2)Utah State University, (3)USDA-ARS Plant Genetic Resources Unit

Crop land in the Intermountain West is being developed for housing, pushing agriculture to peripheral salty land. Existing apple rootstocks exhibit salt stress symptoms as soil salinity increases. The USDA apple rootstock breeding program has some germplasm that is putatively salt tolerant. The purpose of this project is to evaluate the salt tolerance of this germplasm. This is done in a two-part project. Using a near-continuous dosing system in a greenhouse we grew apple rootstocks for 50 days and evaluated their response to a salt gradient. In 2018 all tested rootstocks exhibited parallel reductions in growth to increasing salt exposure. Three orchards have been established on salty or non-salty sites to test rootstock sensitivity to soil salinity.

Five-Year Performance of Fire Blight Resistant Apple Rootstocks in Alabama *(Poster Board #347)*

Elina D. Coneva*; Enfeng Xu; J. Raymond Kessler and Edgar L. Vinson III, Auburn University

Newly released fire blight resistant apple rootstocks can aid in disease management and improve production sustainability. As part of the multistate NC-140 cooperative research project, an apple rootstock study was established at the Chilton Research and Extension Center near Clanton, Alabama in 2014 aiming to assess 14 newly developed fire blight resistant and size-controlling rootstocks. Low-chill ‘Aztec Fuji’ apple was the scion cultivar used. The following rootstocks were tested: B.10, G.11, G.202, G.214, G.30, G.41, G.935, G.969, M.26 EMLA, M.9-T337, V.1, V.5, V.6, and V.7. Trees are arranged in a RCBD with ten single tree replications and trained to the highly efficient Tall Spindle training system which has not been tested in Alabama before. Tall Spindle is designed to control the vegetative vigor and optimize the crop production especially in the early stage of tree establishment, while providing early returns to the grower. Our fifth-year results suggest trees grafted on ‘V.7’, ‘G.969’, and ’V.5’ produced the highest cumulative yield/tree. In general, the Vineland series of rootstocks ‘V.5’, ‘V.6’, and ‘V.7’ had high productivity, and were the most vigorously growing rootstocks in the present study based on data for trunk cross sectional area. Trees on ‘G.11’ consistently produced the largest mean fruit size ranging between 180 and 206 g through the seasons. ‘Aztec Fuji’ trees grafted on the weak ‘G.214’ rootstock had the highest yield efficiency of 1.18 kg/cm^2 at the end of the fifth season, while trees grafted on ‘V.6’ and ‘V.7’ rootstocks had the lowest efficiency of 0.54 and 0.60 kg/cm^2 respectively. Research is going to continue to assess the production efficiency and fruit quality as a way to achieve more efficient land use and sustainable apple production.

Specified Source(s) of Funding: This project was supported by the Alabama Agricultural Experiment Station and the Hatch program of the National Institute of Food and Agriculture, U.S. Department of Agriculture.

Integrated within-Row Weed Management Strategies for Organic Apple Orchards Results in Trade-Offs for Surface-Applied Wood Chip Mulch *(Poster Board #348)*

Kate L. Brown*; David L. Zakalik; Michael G. Brown and Gregory Michael Peck, Cornell University

Adoption of certified organic apple production in the northeastern United States is constrained in part by frequent summer precipitation that fosters weed germination and growth, including many persistent perennial weeds. Organic growers in this region have few options for effective weed management and often cite weeds as the most constraining management barriers. While previous research studies have shown that mulch can be an effective weed control practice, organic growers currently favor cultivation or mowing, with occasional hand weeding. In an effort to improve efficacy of organic weed management tools while reducing associated time, labor, and equipment costs, researchers sought to develop a more integrated approach to organic weed management. In 2015, a NOFA-NY certified organically managed experimental orchard with 'Honeycrisp'/'Budovsky.9' trees trained as a tall spindle was established at Cornell Orchards in Ithaca, New York. In 2016, a no intervention control, cultivation, and surface-applied wood chip mulch were implemented as main treatments. Sub-treatments of mowing and two organically approved herbicides were then overlaid to complete the randomized, split-plot design. The design includes eight tree rows which are divided into four complete blocks. As part of this long-term, systems-level experiment, weed cover and biomass, weed species biodiversity, soil properties, foliar nutrition, and tree growth are measured annually. Despite an overall increase in weed biomass in 2018, mulch continued to reduce weed biomass by 24% and 35% compared to control and cultivated plots, respectively. When mulch and an organic herbicide were used in the same plot, weed biomass was reduced by 67% on average compared to mulch alone. Mulch plots increased soil organic matter by 14% compared to control plots and 12% compared to cultivated plots. Similar increases were observed for soil carbon, aggregate stability, and soil respiration under mulch. While our study found that integrating mulch into organic apple orchards can reduce weed competition and improve soil health, these benefits came at the cost of tree growth – possibly due to water saturated soils under the mulch. Understanding the best management practices for weed control in organic orchards will require observations over a number of years with varying weather patterns.

Specified Source(s) of Funding: Toward Sustainability Foundation, NYS Soil Health Initiative, Extension-Outreach Assistantship Funding

Cross-Compatibility of Apple Cultivars Determined By *S*-Genotyping *(Poster Board #349)*

Ryan Sheick*[1]; Sara Serra[1]; John Tillman[2]; James J Luby[2] and Stefano Musacchi[1], (1)Washington State University, (2) University of Minnesota

Gametophytic self-incompatibility (GSI) is a reproductive strategy that prevents self-pollination in many flowering plants, including rosaceous fruit trees. The GSI system in apple (*Malus* x *domestica* Borkh.) is regulated by a multi-allelic *S* locus, which consists of clusters of F-box genes (*SFBB*) that are expressed in the pollen and an *S-RNase* gene expressed in the pistil. In apple, the GSI system is prevalent, and most cultivars require cross-pollination to achieve desired levels of fruit set. To improve cross-pollination, growers plant pollinizer varieties into their orchard blocks on the basis of bloom phenology. However, in many cases, understanding of the degree of cross-compatibility between cultivar-pollinizer combinations is incomplete. To determine inter-cultivar compatibility, the *S-RNase* gene was used as a target for characterizing the *S*-genotypes of previously unreported apple cultivars and crabapples that could be potentially used as pollinizers. Additionally, some *S*-genotypes disputed in the literature were resolved in this project. The results of this work are intended to help apple growers identify cross-compatible pollen sources for optimizing orchard plantings and promoting consistent annual crop production.

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Precocious Flowering and Fruiting in Bark-Inlay Grafted Pawpaw (*Asimina triloba*) Trees *(Poster Board #350)*

Sheri B. Crabtree*[1]; Kirk William Pomper[1]; Jeremiah Lowe[1] and R. Neal Peterson[2], (1)Kentucky State University, (2) Peterson Pawpaws

The North American pawpaw (*Asimina triloba*) is a native tree fruit that is in small-scale commercial production across the Eastern United States. Fruit are sold in the fresh market as well as value-added products such as beer, wine, jam, and ice cream. Many farmers and landowners have seedling or wild pawpaw trees that produce small yields and low quality fruit. New commercially available pawpaw varieties are available with higher yields and fruit quality, and these wild and seedling trees could serve as rootstock to enable rapid production from grafts of superior cultivars. Bark inlay is a grafting technique which allows the use of a mature tree up to 8 cm diameter as rootstock. This technique has not been well developed for pawpaw and represents a method for growers to change over to improved cultivars. Seedling pawpaw trees take 7-9 years to produce fruit, whereas trees grafted using traditional methods onto small diameter (~1 cm) rootstock produce fruit in 3-4 years. Rapid growth from bark inlay grafting could shorten time to fruit production even further. Three commercially available pawpaw cultivars with large, high quality fruit and high yields were selected: 'KSU-Atwood', 'Sunflower', and 'Susquehanna'. Three trees of each cultivar were grafted on two dates, early vs. late May at the Kentucky State University Research and Demonstration Farm in 2016, 2017, and 2018. Trees grafted using the bark inlay method in early May had a success rate of 78% in all three years, whereas trees grafted in late May had a success rate of 67% in 2016, 44% in 2017, and 33% in 2018. By year 2, trees grafted in early May had grown an average of 1.2 m compared to those grafted in late May growing 0.83 m. 57% of trees grafted in early May 2016 flowered in spring 2018, while 33% of trees grafted in late May 2016 flowered in 2018. 44% of trees grafted in early May 2016 produced fruit in 2018, 2 years earlier than would be expected with other grafting methods; while no trees grafted in late May 2016 fruited in 2018. Due to a higher success rate, improved growth, and more precocious flowering and fruiting, early May is preferable to late May for performing bark inlay grafting of pawpaw trees.

Fruit Weight, Percent Seed, and Soluble Solids of Pawpaw (*Asimina triloba*) Cultivars and Advanced Selections at Kentucky State University

(Poster Board #351)

Jeremiah Lowe*; Sheri B. Crabtree and Kirk William Pomper, Kentucky State University

The North American Pawpaw (*Asimina triloba*) is a tree fruit native to the Eastern U.S. which is being produced in commercial orchards across the U.S. and internationally, with a small but growing market. There are approximately 50 pawpaw cultivars available, with many of these varieties producing low yields with fruit sizes of 120 grams or less. Pawpaw varieties with fruit weighing over 120 grams are considered to have a large enough fruit size for commercial sale and processing. New high yielding cultivars with excellent fruit quality would further assist in the development of the pawpaw industry. Kentucky State University serves as the National Clonal Germplasm Repository for Pawpaw. Two goals of the Repository research efforts are germplasm acquisition and evaluation. The repository contains over 2000 accessions from 16 different states; additionally, both open pollinated seedlings from superior genotypes and crosses of superior selections have been incorporated into the repository collection. Fruit from seven KSU advanced selections (G4-25, G6-120, G9-109, G9-111, Hi 7-1, Hy3-120, and R3-4) were compared to fruit from the commercially available cultivars 'KSU-Atwood™' 'KSU-Chappell™', 'Mango', 'Sunflower', and 'Susquehanna' on the basis of fruit weight, percent seed, and soluble solids. The selections Hi 7-1, Hy3-120, 'KSU-Chappell™', and R3-4 had the largest fruit, averaging over 180 grams per fruit. 'Susquehanna' and 'KSU-Chappell™' had the lowest percent seed (6.19% and 6.29%), while G6-120 had the highest (14.34%). G6-120 had the lowest Brix reading (18.2) while the selections 'KSU-Chappell™' and Hy3-120 had the highest levels at over 23 brix. Several advanced selections show potential to be promising new releases and have been budded onto seedling rootstock for further evaluation.

Retention of Potassium Following High Annual Application Rates in Peach Trees (*Prunus persica* L. Batsch)

(Poster Board #352)

Brian T. Lawrence* and Juan Carlos Melgar, Clemson University

Prior to dormancy, deciduous fruit trees return mobile nutrients such as potassium (K) from senescing leaf tissue to reserve organs. These nutrients are remobilized the following growing season to developing vegetative and reproductive organs. Excessive K fertilization is common in fruit tree orchards in the southeastern U.S. but higher applications do not necessarily turn into higher concentrations within the fruit. Thus, there is a need for understanding K cycling in trees that receive high K applications. The objective of this research is to determine if high application rates of K are absorbed and primarily mobilized to reserve organs or if uptake is limited and the excessive K is lost from the soil. Three-year-old peach trees were fertilized at two different rates: 1) 136 g tree^{-1} (grower standard); or 2) 680 g tree^{-1} K_2SO_4. Leaf K concentration was quantified during the summer and senescence between October and December. Winter tissue samples from new shoots and older shoots along with soil samples from a depth of 0.15 and 0.45 m were taken to understand resorption proficiency and to quantify leaching, respectively. Trees applied with a higher rate of K had higher leaf K concentration (2.77 ± 0.05%) compared to the standard rate (2.19 ± 0.07%, F = 42.3, $P < 0.001$) along with each date of sampling ($P < 0.01$). Shoots from trees which received a high rate of K had statistically higher K concentrations (0.68 ± 0.01%; $t = 2.15$, $P < 0.05$) than the grower standard trees (0.62 ± 0.01%), although these values do not account for resorption of excessive K applications, suggesting most excess of K may have been lost rather than an increase of K absorption. With additional soil sampling and tree analysis, these results may provide growers an understanding of potassium longevity within orchard systems and optimize fertilizer applications.

Vegetable Crops Management 2 (Poster)

Drip Irrigation Improves Vegetable Crop Yield and Water Use Efficiency on the Texas High Plains

(Poster Board #117)

Hyungmin Rho*[1]; Qingwu Xue[2] and Charlie Rush[2], (1) Texas A&M AgriLife Research - Amarillo, (2)Texas A&M AgriLife Research

The declining water table of the Ogallala Aquifer raises a question on the environmental and economic sustainability of growing conventional field crops on the Texas High Plains. Growers in the region have been looking for alternatives to conventional cropping systems to increase revenue per unit of irrigation water applied. Growing high-value vegetables has been suggested as an option, but reliable scientific information is lacking. To address this shortcoming, a field study was conducted to assess the efficacy of different irrigation practices for growing vegetables in the region. Sweet corn, peppers, and tomatoes were grown under three irrigation practices -- surface drip irrigation without plastic mulch (Ctrl), surface drip with plastic mulch

(Mch), and center pivot sprinkler irrigation (Pvt). Meteorological variables and soil water were measured to calculate crop evapotranspiration (ET) and crop water use efficiency (WUE, defined as the ratio of yield and ET). Physiological parameters at the leaf level were also measured during the growing season. No differences were found at the leaf level physiological parameters, including photosynthesis rate, transpiration rate, and intrinsic or extrinsic WUE among irrigation practices for all three crops. Larger yields resulted under drip irrigation (Ctrl and Mch) compared with sprinkler irrigation (Pvt) for all of the three crops, although the yields under Ctrl and Mch did not differ. Crop ET under Ctrl and Mch was less than that under Pvt, resulting in increased WUE, under drip irrigation compared with sprinkler irrigation. Surface drip irrigation has greater capital expense and maintenance requirements compared with center pivot sprinkler, but may be justified by larger yields and WUE.

Influence of Pre-Plant Root Substrate Nitrogen Levels on Growth of Selected Fruit Bearing Vegetable Seedlings in Cylindrical Paper Pots *(Poster Board #118)*

Jong Myung Choi[*1]; Myong Sun Park[1]; Hyun Cheul Kim[1]; An Se Woong[1] and Chiwon W. Lee[2], (1)Chungnam National University, (2)North Dakota State University

The cylindrical paper pots used for vegetable seedling culture greatly facilitates mechanical transplanting. However, the root substrates inside paper pots dry out fast mainly due to air spaces between paper pots created by chinks between the pot's exterior and the holding tray. Frequent watering is necessary that contributes to the loss of nutrients by leaching during seedling production. This study was carried out to investigate the appropriate concentration of nitrogen added as a pre-planting fertilizer for growing fruit-bearing vegetable seedlings in cylindrical paper pots. For the experiment, the paper pots were made with the root substrate containing perlite (1-3 mm) and peat moss (10-mesh, 10-20% by volume) and they were placed into the 40-cell trays. The concentrations of all essential elements except nitrogen was equal in all treatments and the N concentration was adjusted to 0, 150, 250, 500, and 750 $mg \cdot L^{-1}$ during the substrate formulation. Then, grafted seedlings of cucumber, watermelon and tomato were transplanted and seeds of hot pepper were sown directly into the paper pots. The growth of cucumber, watermelon, and tomato plants were measured at 15, 18 and 21 days after transplanting, respectively, and that of pepper at 5 weeks after seed sowing. The concentrations of macro-elements, pH, and EC of root substrates were analyzed every week. The pH of root substrates gradually increased during the seedling culture indicating leaching of liming materials such as dolomite and calcium carbonate incorporated as pre-planting fertilizer, but the differences in pH among N treatments were not significant. The ECs in all treatments did not changed significantly until one week after the transplanting of seedling grafts and 3 weeks after seed sowing of pepper. The concentration of Ca remained similar over time during the entire experimental period, but the concentration of Mg and K decreased 3 weeks after the seed sowing for the pepper growing root substrate. The concentrations of Ca, Mg, and K showed gradually decreasing tendencies since one week after transplanting of seedling grafts of cucumbers, watermelons, and tomatoes. Based on the growth measurements of plant height, fresh and dry weights of above ground tissue, 250 $mg \cdot L^{-1}$ treatment in tomato and those of 500 $mg \cdot L^{-1}$ in cucumbers, watermelons, and peppers showed the highest growth among N treatments. The seedling growths in the treatments lower than 150 $mg \cdot L^{-1}$ or higher than 750 $mg \cdot L^{-1}$ in N concentrations decreased significantly. In summary, the appropriate N concentration in the root substrate of paper pot was 250-500 $mg \cdot L^{-1}$, and post-planting fertilization at 1 week after transplanting of seedling grafts of cucumber, watermelon and tomato and 3 weeks after seed sowing of hot pepper is required.

Fertigation As a Novel Approach to Water Savings and Nutrient Efficiency in Florida Potato *(Poster Board #119)*

Crystal Snodgrass[*], UF/IFAS Extension Manatee County

Potato is an important spring crop with a value of $146 million in Florida (USDA 2017). A previous 3-year project completed at a private farm utilized sprinkler irrigation as a new technology for Florida potato reducing water usage by 50% compared with conventional seepage irrigation. However, the yield of the sprinkler irrigated potato was 10% lower than the seepage irrigated field and the tuber size was smaller, too. This project is an on-going collaborative effort between UF/IFAS specialists, extension agent, a local producer and the Florida Department of Agriculture and Consumer Sciences. Since 2012, the group has hosted several grower demonstrations to present positive results to the Florida potato industry. **Objective:** To determine the effects of fertigation on tuber yield using sprinkler irrigation in potato. **Methods:** A trial was conducted at the same private farm located in Manatee County, FL during the 2017~2018 growing season. Two treatments with 4 replicates were assigned for this trial: fertigation and dry granular fertilization. The same amount of nitrogen (200 lbs/acre) was applied for these two treatments. For both treatments, 50 and 100 lbs/acre N were applied before planting and at emergence, respectively. For the fertigation treatment, 3 fertigation events were operated with 15 lbs/acre N liquid fertilizer applied at each event at tuber initiation. For the dry granular fertilization treatment, 50 lbs/acre N was applied in the form of dry granular fertilizer at tuber initiation. **Results:** The fertigation treatment had 5% greater total yield than the dry granular fertilization and 4% greater marketable yield. **Conclusion:** The result indicates that fertigation is a more efficient way to apply fertilizer under sprinkler irrigation than traditional dry granular fertilization. This provides a novel technology for producers to utilize sprinkler irrigation saving water, while simultaneously increasing yield and therefore, economic benefit.

Effects of Living Mulches and Soil Nutrient Management on Growth, Yield and Yield Components of Chili Pepper (*Capsicum annuum* L.) *(Poster Board #120)*

Socheat Han*[1]; Lyda Hok[1]; Leangsrun Chea[2] and Cary L. Rivard[3], (1)Royal University of Agriculture, (2)Georg-August-Universität Göttingen, (3)K-State Research & Extension Center - Olathe

Most of Cambodia agricultural lands are lowland with low soil fertility; thus, there is a limitation for crop productivity. Living mulches and nutrient management strategies are important practices to improve soil and crop productivity. Our field study was carried out at two provinces in Cambodia (Siem Reap and Battambang), followed by two cropping cycles. The objective of this study was to assess the impacts of various living mulches and nutrient sources on growth, yield and yield components of chili pepper. The trials were conducted in split-plot design with four replications consisting of two factors (mulches and nutrient source). The main plot (mulch) treatments were: bare ground, *Arachis pintoi*, morning glory, and straw mulch. The sub-plot treatments consisted of the fertilizer sources: 1) control, 2) cattle manure, 3) UREA, and 4) cattle manure+UREA. All fertilizers were applied at recommendation rate 133.4 kg N ha^{-1}. UREA was applied three times per growing cycle with three-week intervals. The result showed that application of cattle manure+UREA associated with rice straw mulching had significant higher in plant height (47.245 cm), fruit weight (1.625g $fruit^{-1}$), fruit yield (453.025 kg ha^{-1}) and SPAD value (50.355) followed by treatment UREA in plant height (47.071cm), fruit weight (1.565g) per fruit, fruit yield (414.74 kg ha^{-1}) and SPAD value (47.15) in both provinces of the first cycle. In the second cycle, UREA application associated with rice straw mulching resulted in higher plant height (36.35cm), branch number (4 per $plant^{-1}$), fruit number (12 $plant^{-1}$), fruit yield (82.235 kg ha^{-1}) and plant biomass (25.325kg ha^{-1}) followed by cattle manure+UREA in plant height (33.975cm), branch number (3 $plant^{-1}$), fruit number (10 $plant^{-1}$), fruit yield (71.808 kg ha^{-1}), and plant biomass (24.22 kg ha^{-1}) at both location. Growth, yield and yield component of living mulches (Morning glory and *A. pintoi*) plots were significantly less than others may be due to competition between chili and living mulches due to these systems had mechanism competition between living mulch and chili pepper.

Specified Source(s) of Funding: Feed the Future Horticulture Innovation Lap

Nitrogen and Boron Effect Celtuce (*Lactuca sativa* L. var. *augustana)* Yield and Quality in Hydroponic Production *(Poster Board #121)*

Zhiwei (Jerry) Pan*[1]; Helen T. Kraus[2]; Kathryn Boys[1] and Chris Gunter[1], (1)North Carolina State University, (2)North Carolina State Univ

This study was conducted to determine the effects of nitrogen and boron on celtuce (*Lactuca sativa* L. var. *augustana*) yield and quality in hydroponics system. Two commercial celtuce cultivars 'Celtuce' and 'Summer 38' were selected for morphological and physiological differences that could potential affect the yield and quality. The study was conducted in 2018 and 2019 in a hydroponics system with 32 troughs and 8 independent nutrient solution resivioir systems on the North Carolina State University campus, Raleigh, NC. Plants received 8 different nutrient levels as the combination of 4 nitrogen levels (50, 100, 150, 200 $mg \cdot L^{-1}$) and 2 boron levels (0.5, 1 $mg \cdot L^{-1}$) through a constant feed system. Photosynthetic rates were measured 5 days after transplanting to the hydroponic system and then measured every 10 days. When harvested, stem fresh weight, dry weight, length, diameter, firmness, soluble solids content, nitrate content and leaves fresh weight, dry weight, number, soluble solids content, nitrate content were measured. The cultivar 'Celtuce' had overall significantly better yield and quality than 'Summer 38' under same conditions. Higher nitrogen treatments resulted in higher photosynthetic rates throughout the cultivation period. The 100 and 150 $mg \cdot L^{-1}$ nitrogen levels significantly increased the yield and quality of celtuce by increasing the stem fresh weight, stem length and diameter, and soluble solids content. Plants under 50 $mg \cdot L^{-1}$ nitrogen had significantly lower yield. The 200 $mg \cdot L^{-1}$ nitrogen treatment improved the yield and quality, but also increased the nitrate content of celtuce. The 1 $mg \cdot L^{-1}$ boron level resulted in increased diameter and firmness of the stem. These results indicate that hydroponic production of celtuce with varying nitrogen and boron levels can increase the yield and quality of finished product.

Fruit Yield of Poblano Pepper (*Capsicum annum L.*) As Affected By Plastic Mulch and Cultivar *(Poster Board #122)*

Juan C Diaz-Perez* and Jesús Bautista, University of Georgia

Plastic mulches are widely used for the production of bell peppers and other vegetables. There is, however, limited information on Poblano pepper crop physiology and production, including the response of this pepper to the use of plastic mulches. Poblano pepper is widely used in the Mexican cuisine for dishes such as 'chiles rellenos' (stuffed peppers). Poblano pepper is of increasing popularity in the U.S. due to its relatively low pungency and rich flavor. The objective was to determine the effects of plastic film mulch and cultivar on fruit yield. The study was conducted in the spring of 2011, at the UGA Horticulture Farm, in a sandy loam soil. Since there are no commercial recommendations for growing Poblano pepper in Georgia, Poblano pepper plants were grown according to Univ. of Georgia Extension Service rec-

An asterisk (*) in front of a name indicates the presenting author.

ommendations for growing bell pepper. The length of experimental plot was 6 m. Plants were established on raised beds (6 x 0.76 m; beds formed on 1.8-m centers). Six-week-old transplants were planted on 13 Apr. 2011 on two rows per bed, with a 30 cm separation between plants and 36 cm separation between rows. The experimental design was a randomized complete block with a split plot arrangement, with plastic mulch being the main plot and cultivar the sub-plot. There were 12 treatments [2 plastic mulch (black and silver) x 6 cultivar (Ancho 211, Don Emilio, Don Matías, Masivo, San Ardo, and Tiburón) combinations]. Results showed that Cultivar San Ardo had the highest marketable yield (103.9 t/ha), while 'Ancho' produced lowest (63.8 t/ha) marketable yield, largest number of marketable fruit (122,000 fruit/ha), and among the smallest fruit size (33 g/fruit). 'Masivo' had fewest numbers of marketable fruit. Plastic mulches of contrasting soil-warming ability (black mulch and silver mulch) of this study had no effect on number of fruit, fruit marketable yield, or individual fruit weight.

Specified Source(s) of Funding: Georgia Vegetable Commission, Georgia Agricultural Experiment Stations

Muskmelon (*Cucumis melo* L.) Yield and Quality Responses to Potassium Fertilizer Sources *(Poster Board #123)*

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Yield and quality of fruiting crops such as melons (*Cucumis melo* L.) require high potassium (K) supply rates. Under field conditions, K availability is limited by numerous plant, soil and climatic conditions/processes, thus necessitating supplemental K fertilization. In this field study, muskmelon (cantaloupe cv 'Primo') fruit yield and quality responses to two potassium fertilizer sources namely, polysulfate (PS; a minimally-processed, low-salt index, low-chloride, multi-nutrient organic fertilizer; 14% K_2O, 17% CaO, 6% MgO and 48% SO_4) and potassium chloride (muriate of potash or MOP; 60% K_2O; a common K fertilizer source) were investigated. The two fertilizer sources and their 50:50 blend were applied at three rates (50, 100, and 150 kg $K_2O \cdot ha^{-1}$) at planting on raised beds (2.2 m-wide) with subsurface drip irrigation and white plastic mulch. Fruit yields ranged from 25 – 32 $Mg \cdot ha^{-1}$ and were generally higher in fields receiving the higher rates (100 and 150 kg $K_2O \cdot ha^{-1}$). Blend treatments elicited yield and quality responses that were slightly better than, but statistically similar to responses to PS treatments. Fruit fresh mass, dry matter content, mesocarp firmness and color were significantly increased by fertilizer applications at the 100 and 150 kg $K_2O \cdot ha^{-1}$. Yield and quality responses to MOP alone were similar to PS effects but generally inferior to responses to blends. The prolonged nutrient release pattern of PS (either applied as a straight or combined with other fertilizers) may explain the observed benefits of the multi-nutrient fertilizer source.

Viticulture and Small Fruits 2 (Poster)

Commercial Pheromones and Attractants Have No Contribution to Increasing Pollination, Fruit Set, and Berry Mass in Highbush Blueberry *(Poster Board #323)*

Lisa Wasko DeVetter, Washington State University and Weixin Gan*, WSU

Washington State is one of the largest highbush blueberry producers in the United States, making this crop important to the regional economy. Blueberry growers usually rent honey bee (*Apis mellifera*) hives for pollination. However, fruit set and yield in western Washington can be low and this may be partially due to poor pollination in the cooler, wetter part of the state. To overcome pollination constraints, growers will apply commercial pheromones and/or attractants. Synthetic pheromones are made to mimic natural pheromones with the intent to affect honey bee behavior and increase foraging. Despite widespread commercial use, the effects of these pheromones and attractants on improving blueberry pollination are unclear. The overall objective of this project is to evaluate the effects of commercial pheromones and attractants on pollination, fruit set, and fruit quality attributes in blueberry grown in western Washington. Four different pheromone and attractant treatments plus two controls were applied to 9-m long plots in a randomized complete block design experiment using 'Draper' blueberry. Treatments include: 1) Bee-Scent (Scentry Biologicals, Inc., Billings, MT), 2) Pollinate Pro (Instar Nuturals LLC, Yakima, WA), 3) Honey Bee Magnet (AgBio Inc., Westminster, CO), 4) SureSet-Apex (Fusion360, Inc., Turlock, CA), 5) Water control (treated with distilled water), and 6) No-water control. Honey bee visitation, fruit set, average berry mass, seed number, firmness, and °Brix were measured in 2018. Results show that Pollinate Pro had the highest honey bee visitation rate, while the no water control and SureSet-Apex had the lowest visitation rates. However, these differences were slight and may not be biologically or economically significant for growers. Fruit collected from Pollinate Pro treated plots were less firm than fruit from the water control, Honey Bee Magnet, and SureSet-Apex treatments. No differences in fruit set, seed number per berry, °Brix, nor fruit size were observed. The experiment will be repeated in 2019, but current data suggests commercial pheromones and attractants do not increase honey bee foraging and that growers should consider other strategies to improve pollination.

Specified Source(s) of Funding: Washington Blueberry Commission

Determining Optimal Nitrogen Sources and Rates for Organic Highbush Blueberries Grown on High pH Soils. *(Poster Board #324)*

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culture Research and Extension Center; Joan R. Davenport, WSU Prosser; Gwen Hoheisel, WSU Regional Extension Specialist, Benton County Director; Nathan Eugene Stacey, Washington State University and Lisa Wasko DeVetter, Washington State University Northwestern Washington Research and Extension Center

Acidic soils with high organic matter content are recommended for optimal blueberry growth. However, blueberry production east of the Cascade Range in the Washington State utilizes native soils that are naturally high in pH, have high free calcium carbonate content, and are low in organic matter. These edaphic factors affect nutrient cycling and availability, which ultimately affects plant growth and development. Even though growers have historically amended the soil to lower pH, few studies have been conducted on organic blueberry nutrient management in this economically important region. Growers need additional recommendations so they can optimize nutrient management and the long-term productivity of their plantings. The overall objective of this study was to evaluate the impacts of different commercially available organic nitrogen (N) sources and rates in organic blueberry grown in eastern Washington soils and measure treatment effects on plant growth, yield, and fruit quality. Four commercially available organic N fertilizer treatments and three rates were evaluated in a field established as a split plot randomized complete block design using 'Duke' blueberry. Fertilizer source treatments include: 1) Blood meal (14-0-0); 2) TRUE 402 fish emulsion (4-0-2); 3) WISErg (3-2-2) derived from digested plant materials; and 4) Combination (40% blood meal and 60% WISErg). Fertilizer rate was split within source at 57, 112, and 168 $kg \cdot ha^{-1}$ N. Yield, fruit quality, vegetative growth, and leaf nutrient concentrations were measured in 2018. Overall, TRUE 402 applied at 57 $kg \cdot ha^{-1}$ had the highest yield compared to any other fertilizer treatment whereas WISErg applied at 168 $kg \cdot ha^{-1}$ had the lowest yield. Higher rates of fertilizer tended to encourage greater shoot growth and lower yields. No significant difference was observed in N leaf concentration among the treatments. Fruit quality variables such as berry mass, firmness, °Brix, and Titrable Acidity (TA) were unaffected by the treatments. This study is in progress and will continue to be monitored in 2019.

Specified Source(s) of Funding: Northwest Center for Small Fruits Research

Bioclimatic Models to Predict Lowbush Blueberry Phenology and Interannual Yield Variability in Quebec, Canada *(Poster Board #325)*

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Weather conditions have a significant influence on the development and interannual yield of lowbush blueberries (19 to 3826 kg/ha for the years 1988 to 2018). A bioclimatic model that would predict the phenological development and yield of lowbush blueberries would be very useful for planning field activities (e.g. pollination, pest control), harvesting operations and marketing of this crop. In addition, such bioclimatic models would be very useful in climate change studies to provide future projections for this crop in eastern Canada. Several weather factors can influence the productivity of lowbush blueberries. An increase in fall temperatures could delay hardening and provide less protection against winter frosts. A lower snow cover would increase the risk of plants being exposed to extreme cold. Higher temperatures in the spring could anticipate bud break and make plants more vulnerable to late spring frosts. The severity of such damage varies mainly according to frost intensity and the phenological stage of the crop. To build this bioclimatic model, lowbush blueberry yield data obtained for the Saguenay Lac-St-Jean (SLSJ) regions from 1988 to 2018 were used. The daily weather data used for these years was obtained from the Canadian climate database at a resolution of 10 km. To determine links with weather data, the following variables were selected: minimum, maximum and average temperatures, precipitation, potential evapotranspiration, estimated snow depth and estimated soil temperature at 5 cm. A bioclimatic model that predicts in-season phenological stages of lowbush blueberries was also developed, implemente and used for the yield model. For the bioclimatic model corresponding to the day after the "Mature Fruit - Harvest" stage, the variables with the highest correlation with yield are the cumulated weighted temperatures during the flowering period, the number of frost days during the flowering period, the maximum snow depth in March and the average rainfall during flowering. The proposed model explains 64% of the interannual variability in yield between 1988 and 2018. Excluding the year 1998, in which a major killing frost occurred during the flowering period and resulting in a yield of only 19 kg/ha, the model using the same weather variables explained 82% of the variability in yield. Such a model is therefore very promising as a decision-making tool for lowbush blueberry producers of SLSJ regions in eastern Canada.

Ethylene-Regulated Fruit Ripening in Blueberry

(Poster Board #326)

Yi-Wen Wang*; Anish Malladi; John W. Doyle; D. Scott Nesmith and Savithri U. Nambeesan, University of Georgia

In climacteric fruits, ethylene affects several physiological processes that occur during ripening, such as softening, changes in content of sugars and acids, accumulation of pigments and susceptibility to pathogens. Collectively, these changes can affect fruit quality at harvest. In blueberry fruit, the role of ethylene in ripening has not been very well investigated. We determined ethylene levels in blueberry cultivars 'Premier' and 'Powderblue' during ripening. Our results indicated that both the cultivars produce ethylene during ripening but at varying levels. Further, we

An asterisk (*) in front of a name indicates the presenting author.

determined the effect of ethephon, a plant growth regulator (PGR) that releases ethylene, on ripening in the two cultivars. Application of ethephon increased fruit ethylene levels by 6-fold and 2-fold on 2 and 5 days after treatment respectively. In addition, ethephon promoted fruit ripening by increasing the proportion of blue (ripe) fruit . To determine fruit quality, ripe fruit were harvested approximately 10 days after the application. In general, all fruit quality characteristics such as fruit texture, weight, juice pH, total soluble acids, and titratable acidity were not affected by ethephon except for a decrease in juice pH in 'Powderblue'. In contrast, our preliminary data suggests that application of aminoethoxyvinylglycine (AVG, an inhibitor of ethylene biosynthesis) and 1-methylcyclopropene (1-MCP, an inhibitor of ethylene response) did not delay fruit ripening and had no effect on fruit quality attributes at harvest except for an increase in puncture after 1-MCP treatment. We are currently performing RNA-Seq analysis to elucidate the mechanistic role of ethephon/ethylene in blueberry ripening. Further information on the PGR-effect on ripening will be useful to the blueberry industry to manipulate ripening and reduce production costs.

Flavor Volatile Evaluation of Southern Highbush (*Vaccinium corymbosum* Camp) and Rabbiteye (*V. virgatum* Aiton) Blueberry Culitvars *(Poster Board #327)*

Srijana Thapa Magar* and Rachel A. Itle, University of Georgia

Blueberry (*Vaccinium* spp.) industry is a rapidly blooming industry in Georgia and across southeastern US. It ranks second after pecan in terms of Georgia fruits and nuts farm gate value, 2016. Its growing popularity is mainly due to its flavor and high antioxidant property. Southern Highbush and Rabbiteye, both native to southeastern US, are the predominant blueberry types in Georgia. However, there lies a subjective perception about fruit quality between these two blueberry types. Often rabbiteye blueberries are considered to have lower fruit quality compared to southern highbush. Fruit quality is an important aspect and can directly impact the market value. One of the important component of fruit quality is flavor. Flavor involves both taste and aroma and has a large impact on consumer acceptability. The main objective of this study is therefore to determine and evaluate flavor volatiles in different cultivars of these two blueberry types. Twelve major blueberry cultivars currently grown in Georgia were collected fresh, six of southern highbush (Emerald, Camellia, Star, Farthing, Sweetcrisp, Legacy) and six of rabbiteye (Vernon, Alapaha, Premier, Powderblue, Brightwell, Austin), directly from the growers from April to July, 2016. They were then packed in coolers and brought to University of Georgia, Griffin Campus, IQF at -15 °C until further fruit processing. Four of six rabbiteye cultivars were frozen samples. Gas chromatography-mass spectrometry (GC-MS) was then used to determine flavor volatiles present in each blueberry varieties. All the varieties were examined for 11 volatile compounds; 5 of which contribute to blueberry flavor (geraniol, linalool, cis-3-hexen-1-ol, trans-2-hexenol, and trans-2-hexenal) and rest 6 commonly found in *Vaccinium* spp. (hexenal, limonene, nerol, 1,8-cineole, 1-penten-3-ol, and terpineol,). Relative concentration of each volatiles were determined and the data were analyzed using ANOVA in SAS software at p-value <0.05. 'Premier', 'Vernon', 'Alapaha', and 'Brightwell' had significantly higher relative concentration of most of the volatiles compared to the rest. None of the cultivars contained 'cis-3-hexen-1-ol' and '1-penten-3-ol' from one of those five and six compounds respectively. In comparison of blueberry types, rabbiteye had significantly higher amount of most of the volatiles compared to southern highbush except for 'geraniol' and 'trans-2-hexenol' (insignificant). Results indicate that rabbiteye type has more blueberry flavor compared to southern highbush.

Keywords: Specialty crop, fruit crop, flavor profile

Evaluating the Influence of Ethylene on Performance of Blueberry Fruit Quality Attributes in Fresh Postharvest Storage *(Poster Board #328)*

Rion Mooneyham* and Rachel A. Itle, University of Georgia

Three main commercial types of blueberry are grown for the United States blueberry market. These are northern highbush (NHB, *Vaccinium corymbosum* L.), rabbiteye (RE, *V. virgatum* Aiton), and southern highbush (SHB, *Vaccinium* sp., which is a species complex between *V. corymbosum* L. and *V. darowwi* Camp). NHB blueberry types are grown in northern states of the country. The specific role of ethylene and its influence during fruit ripening and postharvest storage of blueberry is still largely debated. The main objective of this study was to investigate if ethylene levels contributed any influence to the performance of fresh postharvest keeping quality characteristics of SHB, RE, and NHB type fruit held in cold storage during a 30 day period. SHB, RE, and NHB blueberries harvested during the 2018 season were used in this study. Fruit were collected from commercial packers representing the early-, mid-, and late-2018 harvest season from Michigan, Canada, and Georgia. Cultivars included were: seven SHB ['Star', 'Farthing', 'Meadowlark', 'Legacy'(from GA and MI), 'Camellia', 'Keecrisp', and 'Suziblue'], five RE ('Vernon', 'Alapaha', 'Brightwell', 'Powderblue', and 'Austin'), and five NHB ('Bluecrop', 'Draper', 'Nelson', 'Elliott', and 'Liberty'). All except 'Powderblue', 'Austin', and 'Brightwell', were hand-harvested. Fruit were kept at 4 °C after collection and processed for a 30 day period at four timepoints (TP): 1) 3-4 days, 2) 10-11 days, 3) 20-21 days, and 4) 30-31 days. Physical characteristics evaluated included: skin strength (puncture-in), and fruit firmness (Kramer shear). Chemical characteristics evaluated include: soluble solids, total titratable acidity, and sugar/acid ratio. A Shimadzu GC 17-A was used to collect ethylene measurements during TP 1. In this evaluation, ethylene measured during TP1 was correlated to physical and chemical fruit characteristics of TP 1 and TP 4 using Pearson's correlation coefficients. Correlations were also performed between physical and chemical fruit characteristics within each timepoint. Significant differences for all quality characteristics ($P \leq 0.001$) were found for types and cultivars within TP1 and TP4. Additionally, ethylene measurements significantly correlated ($P \leq 0.05$) to fruit firmness (Kramer Shear) in NHB during TP1, and to skin strength (puncture-in) during TP1 and TP4 for both RE and SHB. This suggests that ethylene may have a close relationship with fruit texture changes in postharvest fresh storage. This information will be used to help growers and breeders select cultivars of high postharvest textural quality, and in the development of breeding tools for the creation of new cultivars with superior postharvest keeping quality.

Comparing Consumer Sensory Overall Liking and Textural Traits to Seed and Fiber Instrumental Analyses of Southern Highbush, Rabbiteye and Northern Highbush Blueberry Cultivars

(Poster Board #329)

Kathleen Amaral* and Rachel A. Itle, University of Georgia

Three main blueberry types are grown in the United States: southern highbush (SHB, *Vaccinium corymbosum* L. and *V. darrowii* Camp), rabbiteye (RE, *V. virgatum* Aiton), and northern highbush (NHB, *Vaccinium corymbosum* L). Within the blueberry industry, there has been a subjective bias that NHB have superior fruit quality than that of SHB and RE. Yet, there are limited objective and subjective information comparing instrumental and consumer sensory perception of the major cultivars of the three main commercial types. The main objectives of this study were to evaluate consumer sensory perception of overall liking, texture, grittiness and seediness, determine seed and fiber trait content using instrumental analyses, and compare overall liking to textural trait consumer sensory perception and instrumental analyses of SHB, RE, and NHB. Nineteen cultivars were collected from Georgia, Michigan and Canada commercial packers during the 2018 harvest season with eight SHB cultivars: 'Star', 'Farthing', 'Keecrisp', 'Meadowlark', 'Suziblue', 'Legacy' from GA, 'Legacy' from MI, and 'Camellia'; five RE cultivars: 'Vernon', 'Alapaha', 'Powderblue', 'Austin, and 'Brightwell'; and six NHB cultivars: 'Draper', 'Bluecrop', 'Nelson', 'Elliot', 'Aurora', and 'Liberty'. Seed traits (plump, shriveled and percent seed: berry weight ratio) and fiber traits (% Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), lignin, hemicellulose and cellulose) were instrumentally measured. Five consumer sensory panels were conducted using the same 84 consumers, to assess sensory characteristics using a 9-point hedonic scale (1= extremely dislike, 9= extremely like). SHB cultivars were ranked highest for overall liking, texture, grittiness, and seediness compared to NHB and RE ($P \leq 0.0001$). SHB and NHB fruit significantly contained the smallest percent seed: berry wt ratios ($P \leq 0.0001$). RE fiber traits were significantly larger than that of SHB and NHB ($P \leq 0.0001$). Consumers preferred SHB grittiness, texture and seediness compared to that of NHB and RE. Results from this study suggest that overall liking highly correlates with a crisp texture, small % seed: berry wt. ratio, and smooth texture. Awareness of fiber content may also lead to consumers willing to pay and buy more blueberries, which may increase Georgia's fruit demand and profit.

Fruit Quality Affected By Ethylene-Absorbent and Sulfur Dioxide Generating Pad during Cold Storage in Blueberry (*Vaccinium corymbosum*)

(Poster Board #330)

Hye-sung Cho*; Hyeon-ju Jeong; Moon-young Park; So-mi Lee and In-taek Hwang, Jeollanam-do Agricultural Research and Extension Services

The industrial volume of Korean Blueberry has sharply increased to 3,000ha in 2018 from 20ha in 2006. This is largely attributed to the convenience to consume blueberries as well as high nutritional value. However, the market supply is intensively concentrated during June to July and the shelf life of fresh blueberries is too short, so the quality control of blueberry became more important.

This experiment was conducted to extend the shelf life of fresh blueberries. The varieties used in this experiment were Brightwell and Tipblue. Blueberries (100g) were stored in a plastic pack with a commercialized 'Ethylene-Absorbent Pad (EA)' and 'Sulfur Dioxide Generating Pad (SD)' each. Fruits packs were wraped with polyethylene film and stored at 1°C. Then, the fruit quality such as fruit weight loss, firmness, soluble solid content and decay was monitored by every two weeks

12 weeks after storage, the fruit decay of Brightwell and Tipblue was 0%, 0% in SD treatment but 25.0%, 9.7% in EA compared with 26.3%, 11.3% in control. The total non-commodity rate of Brightwell and Tipblue was 60.3% and 26.0% in EA treatment but 0%, 1.0% in SD treatment.

The fruit weight loss of Brightwell and Tipblue was 0.6 to 0.8% and 2.0 to 2.3% in EA and SD at 12 weeks after storage. The fruit firmness of Brightwell was 0.39kgf in SD and 0.27kgf in EA but the fruit firmness of Tipblue decreased slightly but there was no difference between treatments. Soluble solid content also decreased (In Brightwell, 13.4°Bx at the beginning of storage to 12.5° Bx at 12 weeks after storage; In Tipblue, 14.3°bx at the beginning of storage to 12.7° Bx at 12 weeks after storage) but there was no difference between EA and SD.

Key words : Blueberry, Sulfur Dioxide Generating Pad , Storage, Decay

Specified Source(s) of Funding: Rural Development Administration, Republic of Korea

Co-Expression of Host and Pathogen Genes in Blueberry Fruit Infected with*colletotrichum Fioriniae* *(Poster Board #331)*

Patrick Abeli*, Michigan State University and Randolph Beaudry, Michigan State Univ

*Colletotrichum fioriniae*is a major fungal pathogen of blueberry (*Vaccinium corymbosum*) and is the causal organism of anthracnose fruit rot in Michigan. *C. fioriniae*employs different infection strategies based on the cultivar of blueberry fruit it infects ranging from intramural hemibiotrophy to intercellular necrotrophy. Little is known about the genes involved in the blueberry-anthracnose pathosystem, so we used a time-course based, RNA-sequencing approach to better elucidate the mechanisms involved in establishing a successful infection in the susceptible cv. 'Jersey' and resistant cv. 'Elliott.' We leveraged network analysis to identify modules that are up-regulated in blueberry fruit challenged with *C. fioriniae*, primarily those modules associated with antioxidant metabolism and redox scavenging. Additionally, we analyzed modules that are up-regulated in *C. fioriniae* during various stages of the infection with particular focus on putative effector genes. Overall, our analysis informs highbush blueberry breeding efforts by demonstrating that the infection of blueberry fruit by *C. fioriniae*is a nuanced, cultivar dependent system.

Reduction of Photosynthetic Rate in Blueberry(-Vaccinium spp.) Infected with Ralstonia Pseudo-slanacerum strainP824 *(Poster Board #332)*

Crystal Conner*[1]; S. Christopher Marble[2]; Jianjun Chen[1]; Ana Maria Bocsanczy[2]; Brantlee Richter[2] and David Norman[2], (1)University of Florida, Mid-Florida Research and Education Center, (2)University of Florida

Ralstonia solanacearum is the causal agent of bacterial wilt, a disease with devastating effects on a wide host range of plants including members of the Ericaceae family. An aggressive population of *R. solanacearum* (currently renamed as *Ralstonia pseudosolanacearum*) has been shown to infect highbush, lowbush, rabbiteye and wild type blueberries with devastating effects. The objective of this project is to demonstrate that photosynthesis is reduced in blueberry highbush Arcadia™ 'FL07-399 when *R. pseudosolanacearum* strain P824 (sequevar 13) infects the host, even in the absence of visible disease symptoms. Fluorometers have been developed which measure fluorescence yield under ambient light conditions and even under full sunlight. This allows for very sensitive fluorescence measurements in greenhouse and field and to evaluate reductions of photosystem II (PSII) activities caused by stress. These results will allow early detection of the disease in blueberry plants or hidden reservoirs in tolerant plants. Eight plants were inoculated with P824 bacterial suspensions by cutting the stem and applying 10^3 cells to the wound site. Plants were maintained in a greenhouse with controlled temperature and lighting for 45 days. At the end of the experiment a LI-COR6800 fluorometer was used to measure CO2 levels and fluorescence by measuring 3 apical leaves per plant with 5 readings per leaf. Bacterial populations are being isolated from stems of symptomatic and asymptomatic plants to confirm infection. Preliminary analysis shows differences in CO2 output between symptomatic and asymptomatic plants. We expect to confirm that photosynthetic activity is reduced in infected plants even in the absence of symptoms.

Ecological Physiology (Poster)

Associating Rootstock-Based Variation in Whole Plant Physiological Traits with Leaf Carbon and Oxygen Isotope Composition in *Malus* x *Domestica* borkh. *(Poster Board #049)*

Erica Casagrande Biasuz*, Washington State University - Tree fruit research center and Lee Kalcsits, Washington State University

Rootstocks are critical for *Malus* x *domestica* Borkh. (apple) production to enhance fruit quality and productivity that increases economic returns for apple producers. With new apple cultivars being introduced in the market and increasing environmental concerns, the need of improved rootstocks. While variation in the dwarfing capacity of rootstocks have been widely described, the physiological mechanisms controlling dwarfing have not been identified. Developing a physiological understanding of how rootstocks affect plant water relations may offer a great opportunity to develop better rootstocks in the future. Currently, there is an assumption that the changes to the graft union and xylem conduit structure may increase hydraulic resistance and thus, decrease plant vigor for dwarfing rootstocks. Anatomical traits and physiological manipulation of water status may be correlated, and both may influence rootstock and scion development. Both carbon and oxygen isotope composition have been previously associated with carbon dioxide and water exchange with the atmosphere that has been closely associated with stomatal control. Here, `Honeycrisp` apple trees grafted on G.87, G.210, G.814, G.969, G.935, G.890, CG.5257, CG.4292, M.26 and B.9 and `WA38` apple trees grafted on CG.4010, CG.4213, CG.4288, CG.4292, CG.4809, CG.5030, CG.5087, CG.6040, CG.4213 were used to link leaf-level physiological traits with carbon and oxygen isotope analysis. Measurements included transpiration rate, stem water potential and stomatal conductance and were compared with leaf carbon and oxygen isotope composition and shoot growth. Both stomatal conductance and stem water potential were correlated with the plant growth in both cultivars, `Honeycrisp` and `WA38` (r^2= 0.08; P-value 0.003). Furthermore, there was a significant effect of rootstock on leaf carbon and oxygen isotope composition which can indicate changes in stomatal control and/or leaf anatomy. For the same cultivar, it was possible to observe differences in shoot length over the growth in the season.

Moreover, rootstocks had a significant impact on stomatal conductance and stem water potential, therefore, these areas should be the focus to understand the specific effects of rootstocks on plant water status and specifically, the plant components of the soil-plant-atmosphere continuum.

Allelopathic Effect of *Ficus Microcarpa* L.f. on Seed Germination of Three *Compositae* Species

(Poster Board #050)

Qian Song[1]; Jinye Zhou[1]; Donglin Zhang[*2]; Shuming Luo[1]; Dayan Tao[1]; Shikai Guan[1] and Haixia Yan[1], (1)Flower Research Institute of Guangxi Academy of Agricultural Sciences, (2)University of Georgia

Allelochemical can inhibit or stimulate growth and development of nearby plants of the same or other species. *Ficus microcarpa* L.f. is the plant that produces one or more these biochemical. Allelopathic effect of water extract from fresh biomass of *F. microcarpa* on germination and initial growth of *Cosmos sulphureus* Cav., *Tagetes patula* L. and *Zinnia elegans* Jacq. were investigated. Extract from leaf, fruit and root in the concentration of 25, 75, 125 and 175 g/L were applied to the seeds in petri dishes. The results revealed that germination and initial growth of three species were significantly inhibited by the *F. microcarpa* extract. Generally, the germination percentage and initial growth of three plants decreased as extract concentrations increased. The allelopathic sensitivity of three plants was *Z. elegans* > *T. patula* > *C. sulphureus*. Fruit extract showed the stronger allelopathy ability than that of leaf and root and *Z. elegans* was even killed by fruit extract when the concentration was more than 125 g/L. Leaf extract had less allelopathic effect on *T. patula* (germinated at 77 to 79%, 76% for the control), *C. sulphureus* (60-73%, 63%), and *Z. elegans* (77-85%, 97%). As the concentration from fruit extract increased from 25 to 175 g/L, the germination percentage decreased from 69 to 39% for *C. sulphureus*, 76 to 10% for *T. patula*, and 87 to 0.7% for *Z. elegans*. To design or plant a garden with *Z. elegans*, gardeners should not sow its seeds under or near *F. microcarpa*, especially during the fruit-dropping season.

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Use of Stable Carbon Isotopes to Assess Photosynthetic Response of Redbay Trees to Laurel Wilt *(Poster Board #051)*

Raiza Castillo[*1]; Bruce Schaffer[1]; Aime Vazquez[1] and Leonel D.S.L. Sternberg[2], (1)University of Florida, (2)University of Miami

Redbay (*Persea borbonia*), a member of the Lauraceae family, is a tree native to forests of the southeastern United States. It is planted as landscape tree and used as a medicinal and ceremonial plant by the Seminole tribes. Most members of the Lauraceae family, including redbay, are susceptible to laurel wilt, a devastating vascular disease caused by the fungus *Raffaelea lauricola*, which was introduced into the United States in 2002. Trees respond to laurel wilt by rapidly developing gums and tyloses (outgrowths of xylem vessel cells) impeding water and nutrient transport. Infected trees wilt and eventually die within weeks to months. We used stable isotopes of carbon (C) and leaf gas exchange measurements to determine if inhibition of photosynthesis in laurel wilt-infected trees is due to mainly to stomatal factors in response to water stress. Two-year-old redbay trees were inoculated with *R. lauricola* or deionized water (control). Disease symptoms (visual rating of 1-10 with 1 indicating no symptoms), net photosynthesis (*Pn*), transpiration (*Tr*), stomatal conductance (*gs*), substomatal CO_2 concentration (*Ci*), leaf nitrogen (N) content, and the ratio of $^{13}C/^{12}C$ ($\delta^{13}C$) were determined prior to inoculation and when inoculated trees exhibited disease symptoms. At the end of the experiment stem segments of all plants were plated on a semi-selective medium for recovery of the pathogen. *R. lauricola* was recovered from all infected trees and none of the controls. Infected trees had lower *Pn*, *Tr*, *gs*, and higher *Ci* than control trees. There was a positive linear correlation between *Pn* and *gs* in inoculated and control trees. Leaf N content was linearly correlated with $\delta^{13}C$ in control trees. Therefore, leaf N content was used as a covariate to assess the effects of the disease on $\delta^{13}C$. Redbay trees infected with laurel wilt had higher (less negative) $\delta^{13}C$ values than the controls. The decrease in $\delta^{13}C$, Tr, and *gs* that we observed in inoculated trees is similar to what has been observed in drought stressed trees of other species. However, we also observed an increase in *Ci* in inoculated trees, which is opposite of what is expected if inhibition of photosynthesis is due to solely to stomatal factors as in the case of drought stress. Thus, reduced *Pn* in redbay trees with laurel wilt appears to be due to both stomatal and non-stomatal (biochemical) factors.

Field Screening Approaches for Monitoring Whole-Plant Response Modulated By Biostimulants *(Poster Board #052)*

Meerae Park[*], University of California - UC Davis and Zhehan Tang, UC Davis

Biostimulants are the most rapidly growing segment of the Agricultural Chemicals industry, nevertheless, considerable uncertainty exists with regard to application rates, timings, crop responses, and mode of action. Skepticism among consumers and regulators as to the role of these products in modern agriculture further hampers adoption. To address this issue there is a need to develop university managed, rapid screening protocols that are independent, statistically robust, and low cost. The UC Davis Biostimulant Field Screening Trial is an investigation of physiological parameters related to biomass accumulation and energy balance of *Lycopersicon* esculentum *Mil* in order to charac-

An asterisk (*) in front of a name indicates the presenting author.

terize whole-plant response of biostimulant treated plants to multiple-stressor conditions in commercial fields. This trial utilized the latest in sensing technologies and ground-truth devices to characterize *Lycopersicon* esculentum *Mil* phenology and to identify critical periods of biostimulant activity.

Specified Source(s) of Funding: Industry Funding

Competition Effects on Maple Sap Flow and Tree Growth in Nova Scotia. *(Poster Board #053)*

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The Canadian maple industry dates back to the 1500's and now supplies the world with more than 80% of its maple syrup, making it vital to the Canadian culture and economy (grossing >$380 million, 2018). Quebec accounts for ~92% of the 47.3 million litres of maple product produced by the Canadian industry in 2017, while Nova Scotia supplies 1%. Nova Scotia's production has continued to increase from ~72,000L in 2015 to ~216,000L in 2017, even though the average tap yield has decreased over the years. This study's intent was to explore tree health and various environmental factors to determine relationships with sap yield and flow. One hundred trees, on ten sites, in major maple production regions of Nova Scotia, were chosen to represent Nova Scotia's maple industry. Factors studied included site characteristics, tree growth, nutrient status, environmental conditions, and vegetative competition. Data was gathered from June 2015 to April 2017 and compared to sap flow and yield from the spring of 2016 and 2017. The focus of this investigation was on vegetative competition from other trees (>1.5 meters tall), and low vegetative growth (<1.5 meters tall). Vegetative measurements were taken with two large quadrats (10m X 10m) and 10 small quadrats (1m X 1m) for tall and low growth, respectively, in July 2016. Significant negative relationships were found between total tree seedlings and average sap flow in year 1 (R^2 value 0.20) and year 2 (R^2 value 0.34), and between the year 1 yield and total small plant stems (R^2 value 0.29). Overall, competition was found to have a small, but significant, negative effect on sap yield and flow, with no effects on sap brix. Additional years of study would be needed to gain a better understanding of the effects of vegetative competition in the sugar bush.

Specified Source(s) of Funding: Growing Forward 2

Precision Irrigation Set-Points Affect Kale Biomass Accumulation and Physiological Performance *(Poster Board #054)*

T. Casey Barickman*, Mississippi State University and Kang-Mo Ku, Chonnam National University

Water management is becoming an increasing concern in agriculture, whether dealing with too much or too little. Finding tools and methods to better manage water is critical to future success. Precision irrigation can help growers conserve important resources, such as water and fertilizers, and increase crop water-use efficiency. Previous research has demonstrated that tomato yields, biomass, and water-use efficiency increased when irrigating based on soil moisture sensor reading. Thus, the objective of the current study was to determine the effect of precision irrigation set points on the physiological performance of kale grown in a greenhouse. Kale plants were grown in 3 gal. plastic grow bags in soilless (Metro Mix 360; Sun Gro Horticulture, Agawam, MA) medium and fertilized with a 15N-3.9P-9.9K controlled release fertilizer. The fertilizer was incorporated at a rate of 5.93 $kg \cdot m^{-3}$. Substrate volumetric water content (VWC) was measured using capacitance sensors (Terros 12; Meter Group) and a datalogger (CR1000x; Campbell Sci.) was used to record data and control solenoid valves when bags reached 0.15, 0.25, or 0.35 $m^3 \cdot m^3$, corresponding to well-watered, intermediate drought, and drought stressed conditions. Kale physiological performance parameters, such as net CO_2 assimilation rate (A) and stomatal conductance (g_s) were measured with a LI-6800 (Li-Cor Biosciences) photosynthesis system under each VWC treatment over 31 d. There were significant differences in kale fresh mass (FM), dry mass (DM), transpiration (T), CO_2 assimilation ($A_{n)}$, internal CO_2 (C_i), and water use efficiency (WUE). There were also significant differences in the relationship between stomatal conductance (g_s) and C_i. Additionally, there were significant differences in the transpiration (*T*) of kale leaves. Reducing the VWC in soilless medium, thus conserving water, from 0.35 to 0.25 does not affect kale's physiological performance, FM, and DM.

Specified Source(s) of Funding: This material is based upon the work that is supported by USDA-NIFA, Hatch project 146030

Regulation of Photosynthesis and Stomatal Conductance of Cucumber Under Early Season Waterlogging Conditions *(Poster Board #055)*

T. Casey Barickman*, Mississippi State University and Catherine Simpson, Texas A&M University, Kingsville Citrus Center

Waterlogging occurs in many regions of the Southern United States because of poor soil drainage and/or excessive rainfall. Waterlogging is a serious abiotic stress affecting plant growth because it results in the decline in the supplement of oxygen to submerged tissues. Although cucumber (*Cucumis sativus* L.) is sensitive to waterlogging, its ability to generate adventitious roots facilitates gas diffusion and increase plant survival when the oxygen concentrations are decreased. To gain a better understanding of the physiological responses that enable cucumber plants to survive, in the early season, a 10 d waterlogging experiment was conducted. Thus, the objective of this study was to measure the net photosynthesis and stomatal conductance of cucumber plants under waterlogging conditions and no-waterlogging conditions for 10 days. ‘Straight 8’ cucumber plants were seeded in 4” pots filled with a soilless medium and grown in a plant growth chamber at 23°C/20°C day, night temperature at 16 h photoperiod. They were arranged in a randomized complete block design with four replications. Two weeks after emergence, all cucumber plants were placed in 11 L totes. One-half of the totes were filled with enough water to be 10 cm over the top of the pots to simulate waterlogging conditions for 10 d. The other half of the plants were watered as needed. One day after treatment initiation and over the subsequent 9 d, plants were measured for physiological performance with a Li-6800 (Li-Cor Biosciences) photosynthesis system. Plants were harvested at the end of 10 d and plant height (ht), leaf number and area, fresh mass (FM), and dry mass (DM) were taken for statistical analysis (GLIMMIX; SAS v. 9.4). Results indicated that cucumber plants subjected to the 10 d waterlogging stress conditions were stunted, had fewer leaves, decreased leaf area, FM, and DM. Additionally, those cucumber plants also had a higher DM:FM ratio. Previous research indicated that waterlogging in cucumber plants also had significant differences in shoot dry weight, vine length, and root dry weight. There were also differences in net CO_2 assimilation (A_n) and intercellular CO_2 (C_i) concentrations. Furthermore, there were significant differences in the relationship between stomatal conductance (g_s) and transpiration (T) rate (figure 4) and C_i concentrations. Overall, cucumber plants subjected to a 10 d waterlogging stress period demonstrate decreased growth, A_n and higher C_i concentrations compared to the cucumber plants not subjected to waterlogging stress.

Specified Source(s) of Funding: This material is based upon work that is support by USDA-NIFA, Hatch Project 146030

Relationship between Relative and Absolute Leaf Chlorophyll for *Vitis Vinifera* and *Cannabis sativa* *(Poster Board #057)*

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In 2014, Parry et al. (In situ measurement of leaf chlorophyll concentration: analysis of the optical/absolute relationship; Plant, Cell and Environment) quantified the relationship between optical measurement of relative leaf chlorophyll with a handheld meter (Apogee Instruments model MC-100) and absolute leaf chlorophyll concentration determined by chemical extraction for twenty-two species. While there was some variability among species, Parry et al. derived a generic relationship relating leaf chlorophyll concentration to the relative optical measurement from the MC-100. This generic relationship can be used to reliably estimate leaf chlorophyll concentration for many species from in situ measurements with the MC-100. Using the methods detailed in Parry et al., the relationship between absolute leaf chlorophyll concentration and the relative optical measurement from the MC-100 was derived for *Vitis vinifera* and *Cannabis sativa*, two high value crops that were not included in the study by Parry et al. Data for *Vitis vinifera* indicate a close match to the generic relationship derived by Parry et al., but data for *Cannabis sativa* indicate less chlorophyll per unit of leaf area for a given optical measurement when compared to the generic relationship. This suggests *Cannabis sativa* leaves absorb more photosynthetic radiation with less leaf chlorophyll than any of the species measured by Parry et al., and also suggests the unique equation derived for *Cannabis sativa* should be used to provide accurate in situ leaf chlorophyll concentration estimates using the MC-100.

Fruit Breeding 2 (Poster)

Application of DNA Test for Disease Resistance and Fruit Quality in Cultivated Strawberry *(Poster Board #249)*

Sadikshya Sharma*[1]; Youngjae Oh[1]; Jason D. Zurn[2]; Saket Chandra[1]; Yi-Tien Lu[1]; Cheolmin Yoo[1]; Sujeet Verma[1]; Natalia Salinas[1]; Zhen Fan[1]; Cheryl Dalid[1]; Nahla Bassil[2]; Vance M Whitaker[1] and Seonghee Lee[1], (1)University of Florida, (2)USDA-ARS NCGR

Octoploid Strawberry (*Fragaria* x *ananassa*) production has been challenged by various diseases deteriorating the fruit quality. Selection of the parents and elite lines for breeding against the diseases would be time and resource consuming based on the phenotypic observations. The RosBREED project of USDA-NIFA Specialty Crops Research Initiative project is focused on utilizing genetic information to improve rosaceous crops including strawberry. Utilizing the genetic information through DNA test to facilitate DNA-informed breeding can effectively enhance disease resistance and fruit quality traits. DNA tests help breeders to select superior seedlings and breeding accessions in prior to expensive and laborious phenotypic characterization in the field. In our research, we use various DNA markers for disease resistance and fruit quality for marker-assisted seedling selection (MASS). In the year 2018, we selected 12,500 seedlings out of 53,000 seedlings tested by multiple markers. The rapid DNA extraction and direct PCR genotyping using high-resolution melting (HRM) curve allows us to select only the seedlings with desirable traits. In the year 2019, we are planning to perform MASS for approximately 60,000 seedlings to target traits of disease resistance and fruit quality. The results of this year will be discussed in the conference presentation.

Genomic Prediction for Increasing Resistance to Verticillium Wilt in Heirloom and Modern Populations of Strawberry *(Poster Board #250)*

Dominique D.A. Pincot*; Randi Famula; Glenn S. Cole; Michael A. Hardigan; Thomas R. Gordon and Steven J. Knapp,

An asterisk (*) in front of a name indicates the presenting author.

University of California, Davis

Verticillium wilt, a soil-borne disease caused by the fungal pathogen *Verticillium dahliae*, was initially discovered in strawberry (*Fragaria × ananassa*) in 1931. This widespread pathogen causes significant losses in strawberry production worldwide. Despite extensive research, including 38 previously published studies, the genetics of resistance to this pathogen appears to be quantitative and remains murky—thus far, only one genome-enabled forward genetic study has been reported. While resistant cultivars have been developed, there are only a few highly resistant cultivars, and the frequency of moderately to completely susceptible cultivars is extremely high across the globe. To develop insights into the genetics of resistance, we developed and studied a training population comprised of 480 germplasm accessions including heirloom and modern cultivars representing demographic and phenotypic diversity worldwide. The training population was genotyped with a 49,000-SNP genotyping array and phenotyped for resistance to Verticillium wilt in 2016-17 and 2017-18 field experiments where plants were artificially inoculated and grown in soils that had been fumigated to eliminate the confounding effects of other soil-borne pathogens. We observed a full range of phenotypes from highly susceptible to highly resistant. The broad-sense heritability of resistance was 0.70 in 2017 and 0.60 in 2018, and phenotypes were correlated between years (r = 0.53). Statistically significant signals were not observed in a genome-wide association study (GWAS), indicating that the underlying genetic variation is quantitative in nature. To explore the application of genomic selection for Verticillium wilt resistance, marker-based genomic kinship BLUP was investigated for potential in predicting Verticillium resistance within- and across-years. Our results suggest that breeding for resistance to this pathogen can be improved by applying genomic prediction approaches early in the breeding cycle, before phenotypic selection can be performed.

Combining Ability and Heritability in Day-Neutral Strawberry Populations in Temperate Climate Conditions Under Low Tunnels *(Poster Board #251)*

Courtney A Weber*, Cornell Univ

Day-neutral strawberry production has increased dramatically in the last decade but few varieties have been developed for cooler, temperate regions such as western NY. Most commercial varieties were developed for annual production systems utilizing fumigation for soil pest management and have little or unknown resistance to soil borne pests and poor adaptation to semi-perennial production in heavy soils. The development of new varieties suitable for these conditions is of great interest to regional growers and may be of value in other areas as soil fumigation restrictions increase. However, the expression of day-neutral flowering of some varieties is inconsistent under cool, long day conditions followed by cool, short day conditions as is typical during the late summer and early fall in western NY. Breeding day-neutral varieties for these conditions necessitates the blending of germplasm from multiple geographic locations with unpredictable results. A total of 37 populations developed by combining multiple day-neutral varieties from California and the EU as well as the eastern U.S. heirloom variety 'Tribute' from the USDA with Cornell short-day varieties and other germplasm of mixed day-neutral/short-day genetic background were grown in a modified plasticulture system under low tunnels for 2-years in un-fumigated ground. Seeds were germinated after pre-treatment in the greenhouse under long days in the spring and transferred to plug trays for growth. Plugs were transferred to the field in early summer with low tunnels installed shortly after planting to enhance growth and provide weather protection into the fall for flower and fruit development. The plants were rated in September of the planting year as well as the following September to determine the best combinations for producing day-neutral genotypes for evaluation. Plants were covered with straw in mid-December of the planting year for winter protection and uncovered in mid-March the following spring for the second season of growth. Heritability and general and specific combining ability was calculated for the populations. Day-neutral flowering in the planting year ranged from 4% to 85% with a mean of 46% of the plants producing flowers in different populations. In the second season, the range was 17% to 82% with a 47% mean. 'Verity' and 'Amandine' from the UK and France, respectively, transmitted day-neutrality when combined with Cornell germplasm at a higher rate, 60-65%, than 'Albion' and 'Seascape' from California at 40-50% but all combinations produced many day-neutral types for evaluation.

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Genetic and Physical Mapping of a Fusarium Wilt Resistance Gene in Strawberry *(Poster Board #252)*

Nicolas Cobo*; Dominique D.A. Pincot; Anne Lorant; Michael A. Hardigan; Mirko Ledda; Randi A. Famula; Charlotte Acharya; Glenn S. Cole and Steven J. Knapp, University of California, Davis

Fusarium wilt, a soil-borne disease caused by the fungal pathogen *Fusarium oxysporum*sp. *fragariae*, poses a serious risk to strawberry (*Fragaria × ananassa*) production in many parts of the world. We previously described a dominant gene (*Fw1*) that confers resistance to Fusarium wilt. Here, we describe fine-scale genetic and physical mapping of the *Fw1* locus, and the development of high-throughput DNA markers for marker-assisted selection of *Fw1* alleles. The genomic segment harboring *Fw1* was narrowed down to less than 5 Mb on chromosome Fvb2-4 in a genome-wide associate study (GWAS). GWAS was facilitated by the availability of a high-quality octoploid reference genome, whole-genome shotgun resequencing of susceptible and resistant genotypes, and the development of 49,000 and 850,000-single nucleotide polymorphism (SNP) genotyping arrays. DNA sequences for the SNP probes on these arrays are sub-genome specific and anchored to the octoploid reference genome. We identified hundreds of DNA variants in the haploblock harboring the *Fw1* locus. To facilitate marker-assisted selection, several co-dominant sub-genome specific Kompetitive Allele Specific PCR (KASP) genotyping assays were developed both, for SNPs tightly linked to *Fw1* and for SNPs flanking the candidate region. These KASP assays define a 4.2 Mb candidate region on chromosome 2-4 and accurately predict *Fw1* genotypes in segregating populations. We are currently screening 2,000 segregating progenies to select recombination events within the candidate haploblock, with the goal of identifying candidate genes for *Fw1*.

Genetic Gains for Yield in Strawberry *(Poster Board #253)*

Cindy M. Lopez-Ramirez*, University of California, Davis
Over the last 50 years, breeding has profoundly altered the productivity of garden strawberry (Fragaria × ananassa), greatly distancing modern long shelf-life mass-production cultivars from short shelf-life heirloom cultivars. One of the more profound changes over that period was the introduction of wild species alleles by Royce S. Bringhurst that eliminated photoperiod sensitivity, thereby creating so-called ‘day-neutral’ cultivars. The development and introduction of long-day flowering cultivars expanded the production window from a few months to year round in mild maritime California climates. Selection in parallel for mass-production traits has delivered day-neutral cultivars with high yields of large, well-formed, firm, visually appealing, extended shelf-life fruit that can withstand the rigors of harvest, handling, storage, and long-distance shipping. These breeding advances are anecdotally well known, however, genetic gains for yield and many other mass-production traits have not been well documented or carefully studied in strawberry. Here we describe the results of three years of field testing of day-neutral cultivars developed over the last three decades and show that genetic gains for yield have been dramatic in the University of California, Davis breeding program, with present-day cultivars yielding 50 to 150% more fruit per hectare than their predecessors. Cumulative marketable yields of three newly developed day-neutral cultivars (UC9, UC11, and UC12) ranged from 246,235 to 262,070 clamshells/ha compared to 203,101 to 210,277 clamshells/ha for check cultivars (Monterey and Cabrillo). The ranks of cultivars were highly consistent over years, locations, and production systems, with a broad-sense heritability of 0.70. UC9 and UC12 produced significantly fewer runners than check cultivars in coastal California production environments, a characteristic predicted to significantly decrease runner-trimming labor costs. UC12, the highest yielding cultivar, was found to be highly resistant to Fusarium and Verticillium wilt, the two most damaging soil-borne pathogens in organic and conventional production systems in California. The cultivars we tested maintained shelf-life for nearly 21 days (the maximum duration of our post-harvest testing). UC9, UC11, and UC12 have the potential to deliver exceptionally high yields of marketable fruit over the long harvest season in coastal California and comparable long-day production environments.

Specified Source(s) of Funding: University of California, USDA National Institute of Food and Agriculture Specialty Crops, California Strawberry Commission

Heterosis and Genome-Scale Diversity Among High Yielding Hybrids of Strawberry *(Poster Board #254)*

Mitchell J. Feldmann*; Michael A. Hardigan; Cindy M. Lopez-Ramirez; Randi A. Famula; Glenn S. Cole and Steven J. Knapp, University of California, Davis
Genetic gains for cumulative fruit yield have been significant in strawberry (*Fragaria*x *ananassa*) over the last 50 years, especially among hybrids selected for production in coastal California environments. From commercial production statistics, we estimate that strawberry yields have increased 10-fold since 1970 despite a stable production acreage. However, common garden experiments have not been conducted to quantify realized genetic gains for yield or to study the effect of intense selection for increased yield on the underlying genetic diversity. Moreover, we hypothesized that heterosis might have played a significant role in driving strawberry yields upwards. To explore these questions, we developed and studied 545 hybrids among elite short-day and long-day parents developed using a factorial mating design, in addition to studying 72 hybrids developed over a 15-year period—parents and hybrids were genotyped with high-density SNP arrays. Genetic diversity appears to be comparatively narrow among the hybrids studied. Heterozygosity ranged from 0.25 to 0.32 among the 72 era-study hybrids and 0.18 to 0.45 among the 545 factorial-study hybrids and was not correlated with fruit yield in either study. High-parent heterosis for cumulative fruit yield was virtually non-existent and was only statistically significant for 34 of the 545 hybrids tested (6.2%). Consistent with these results, we found no evidence for heterotic groups in the population under study, which includes public germplasm that has played an important role in the expansion of strawberry industry worldwide. We speculate that interactions among genes in homeologous genomes, so-called fixed heterosis, might underlie genetic gains for yield in strawberry.

Specified Source(s) of Funding: California Strawberry Commission funded all or part of the research associated with this abstract

DNA Tests Available through the Rosbreed Projects: A Common Strategy to Enable DNA-Informed Breeding in Rosaceae *(Poster Board #255)*

Stijn Vanderzande*[1]; Lichun Cai[2]; David Chagné[3]; Cassia Da Silva Linge[4]; Margaret Fleming[4]; Ksenija Gasic[4]; Seonghee Lee[5]; Youngjae Oh[5]; Natalia Salinas[5]; Christopher Saski[4]; Vance M Whitaker[5]; Jason D. Zurn[6]; Amy F. Iezzoni[2]; Cameron Peace[1] and Nahla Bassil[6], (1)Washington State University, (2)Michigan State University, (3)The New Zealand Institute for Plant & Food Research Ltd, (4)Clemson University, (5)University of Florida, (6)USDA-ARS NCGR
DNA information has been suggested as a means to enhance accuracy, efficiency, creativity, and pace of new cultivar development in fruit breeding. To use DNA information, a thorough understanding of the genetic control of breeding-relevant traits is needed. A first, but by no means final, step towards such understanding is identifying genomic regions controlling the traits of interest. However, many studies do not pursue development of tools for DNA-informed breeding after the discovery of such genomic regions. Before DNA-informed breeding is possible, an identified genomic region must be translated into a trait-predictive DNA test. To perform this translational step, the RosBREED projects (2009-2019) developed a strategy that was applied across eight Rosaceae crops (apple, peach, sweet cherry, tart cherry, strawberry, pear, rose, and blackberry).

Here we present the strategy to develop DNA tests and the extensive set of DNA tests that have been developed, validated, and used in the RosBREED projects. The strategy for DNA test development involves designing assays to evaluate the region of interest, testing each assay on breeding-relevant individuals, tracing allelic inheritance, and disseminating assay details. Key points to include in the dissemination of the DNA tests are the target crop and trait(s) and targeted genomic region(s), marker type of the DNA test, proportion of phenotypic and genotypic variation explained by the DNA test, alleles identified by the DNA test and their effects, frequencies and distribution among common cultivars, and the technical details to run the DNA test. This strategy resulted in more than 50 developed or refined DNA tests and 17 DNA tests under development for key traits, including: fruit quality traits such as fruit texture, fruit flavor, fruit skin coloration, and fruit size; productivity traits such as bloom timing and cross-compatibility; and disease resistance against major pathogens for each crop. These DNA tests are now available to use in DNA-informed fruit breeding and have already been adopted by many Rosaceae breeding programs.

Biogeographic and *in silico* survey of Native Soil pH of Wild Blueberry Populations (*Vaccinium* spp.) in North America *(Poster Board #256)*

Victoria Young; Charlene Mitchell; Camila I. Arzola and Gerardo H. Nunez*, University of Florida
Blueberries (family ericaceae, genus *Vaccinium*) thrive in acidic soils (pH 4.2 – 6.5) and exhibit stress, limited grown, and reduced yields when grown in higher pH soils (pH > 6.5). As a consequence, growers must select naturally-acidic soils or use costly soil amendments to produce this specialty crop. Thus, there is interest in developing blueberry cultivars that tolerate higher pH soils. Nevertheless, sources for this trait have not been identified. While local adaptation to higher pH soils has been previously documented in other ericaceous genera, there is little evidence for higher pH tolerance among *Vaccinium* spp. In this study, we surveyed native soil pH of wild *Vaccinium* spp. populations in North America. We hypothesized that local adaptation to higher pH soils exists in wild populations of *Vaccinium* spp. Accessions of *V. arboreum* Marshall, *V. corymbosum* L., *V. stamineum* L., *V. ellioti* Chapm., *V. virgatum* Aiton, *V. darrowii* Camp., and *V. myrsinites* Lam. with complete passport information in GRIN-Global were studied *in silico.* Population coordinates were used to gather native soil pH from USDA-NRCS Web Soil Survey. Additionally, soil samples from native *Vaccinium* spp. populations found in the Florida state park system were analyzed. *Vaccinium* spp. were found in soils ranging from pH 4.6 to pH 8.2. *V. arboreum* exhibited greater pH plasticity than other species. These results suggest that local adaptation to higher pH soils exists in this genus, which could be used to breed pH-tolerant blueberry cultivars.

Specified Source(s) of Funding: This research was partially funded by a USDA-ARS Plant Explorations award in 2018.

Sustaining Plant Breeding to Insure Future Innovations: A Partnership between the Plant Breeding Coordinating Committee and the National Association of Plant Breeders *(Poster Board #257)*

Ksenija Gasic*, Clemson University; Michael Kantar, University of Hawaii at Manoa; Kate Evans, Washington State University; Richard Pratt, New Mexico State University; Patrick Byrne, Colorado State University; B. Todd Campbell, USDA-ARS; Wayne Smith, Texas A&M University; Peggy Ozias-Akins, University of Georgia; David Bubeck, Corteva Agriscience; Alex Lipka, University of Illinois and Don Jones, Cotton Incorporated
The Plant Breeding Coordinating Committee (PBCC) and the National Association of Plant Breeders (NAPB) have a long history of collaboration to sustain plant breeding. The PBCC, a multistate coordinating committee of the State Agricultural Experiment Stations within the Land Grant University System, was formed in 2006 to insure the long-term national importance of a strong plant breeding infrastructure and education capacity, and to increase national awareness of plant breeding's contributions to the U.S. economy. From the work of the PBCC, NAPB was formed in 2008, held its first annual meeting in 2011, and officially incorporated as a 501(c)(3) nonprofit corporation in 2012. NAPB is an independent professional society with the goal of advocating

a cohesive national plant breeding agenda in which strong public and private sectors work independently and together to insure the value and importance of plant breeding are known and appreciated. In 2019, NAPB will hold its' 8th annual meeting where the PBCC will also hold its' 14th meeting. In this presentation, we will highlight the work of PBCC and NAPB while describing how the two organizations continue working collaboratively to insure future plant breeding innovations.

Growth Chambers and Controlled Environments 2 (Poster)

Energy-Use-Efficiency Differences between Light Emitting Diode Based Supplemental Lights Under Nutrient Film and Deep Flow Techniques

(Poster Board #168)

Alexander Miller*; Petrus Langenhoven and Krishna Nemali, Purdue University

The bulk of energy costs during winter hydroponic production are associated with supplemental lighting and heating. Our previous research indicated that hydroponic lettuce grown using heated nutrient solution (21 °C) and cooler greenhouse air temperature (16 °C) resulted in good growth and reduced energy costs of heating. Light emitting diodes (LEDs) are increasingly becoming popular in greenhouses due to their increased energy efficiency. Thus, a combination of energy efficient LED lighting and heated nutrient solution can further maximizing electrical energy use efficiency (EUE), defined as the ratio of biomass produced to energy consumed ($g \cdot KWh^{-1}$), in lettuce production. However, differences in spectral composition of LEDs can potentially affect crop growth and energy use, thereby affecting EUE. In addition, electrical energy costs of heating may vary between nutrient film technique (NFT) and deep flow technique (DFT) of growing lettuce due to differences in volume of nutrient solution used between two production systems. Our objective was to compare EUE differences between NFT and DFT systems under LED lighting treatments with different spectral composition and using heated nutrient solution. An experiment was conducted for four weeks during winter using eight different varieties of lettuce belonging to four major groups. Plants were grown in two production systems (NFT and DFT; split levels) and under two supplemental lighting treatments (broadband or white and narrow band or red/blue; main levels) provided at nighttime. Heated nutrient solution (21 °C) was used to grow plants while the greenhouse air was maintained at 16/10 °C (day/night). Both LED fixtures consumed similar energy (1.15 $KWh \cdot d^{-1}$) and produced similar light intensity (12.5 $mol \cdot m^{-2} \cdot d^{-1}$). Results indicated that the interaction between light and production system was significant for EUE. Regardless of variety, EUE was higher in DFT compared to NFT and difference between DWT and NFT was higher under red/blue than white LED fixture. In spite of higher electrical energy consumption for heating under DFT than NFT (approx. 15% higher), EUE was higher under DFT. This may be likely due to better nutrient uptake in DFT than NFT due to increased root exposure to nutrient solution and increased crop growth. Red/blue LED fixture likely optimized light for photosynthesis, which may have further increased crop growth, thereby increasing EUE. In conclusion, our research indicates that maximum EUE in lettuce production could be achieved in a DFT system using heated nutrient solution and narrow band (red/blue) nighttime supplemental lighting.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant and Fluence Bioengineering

Growth and Bioactive Compounds of Kale Irradiated by Various UV-A LEDs *(Poster Board #169)*

Yoon-Seon Choi*, Chungbuk National University, Brain Korea Center for Bio-Resource Development; Jin-Hui Lee, Chungbuk National University and Myung-Min Oh, Chungbuk National University Horticulture

Bioactive compounds such as polyphenolics have beneficial effects on human health. The application of temporary abiotic stresses to plants is a potential strategy to enhance the content of bioactive compounds. The objective of this study was to determine the effect of various UV-A LED lights on the biomass and content of bioactive compounds in kale (*Brassica oleracea* var. *acephala*). Two-week-old kale seedlings were cultivated in a closed type plant production system where air temperature, relative humidity, photosynthesis photon flux density (PPFD) and photoperiod were set at 20°C, 60%, 125 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and 12 hours, respectively, for 3 weeks. After then, kale plants were irradiated by four types of UV-A LEDs (peak wavelength; 365, 375, 385, and 395 nm) with 30 W/m^2 for 7 days. As a result, image chlorophyll fluorescence (Fv/Fm) value of kale leaves was lower as the peak wavelength of UV-A LEDs was shorter. The image Fv/Fm value of UV-A $LEDs_{365nm}$ treatment was 11% lower than that of the control. Fresh and dry weights of shoots and roots were significantly higher in the UV-A treated plants than the control at 7 days of treatment. In particular, UV-A $LEDs_{395nm}$ showed significant increase in growth. The results of leaf area and specific leaf weight tended to be similar to previous growth results. At 3 days of UV-A radiation, chlorophyll content was highest in kale leaves under UV-A $LEDs_{395nm}$ among the all treatment and the control. Total phenolic contents of UV-A $LEDs_{395nm}$ at 5 and 6 days of treatment were 44% and 47% higher than those of the control, respectively, and the tendency was similarly shown in antioxidant capacity. It was supported by the activity of phenylalanine ammonia-lyase, which was increased approximately 11% and 8% by UV-A $LEDs_{395nm}$ irradiation compared to the control at 5 and 6 days of treatment, respectively. These results suggested that the UV-A LEDs with relatively longer peak wavelengths were effective to improve both growth and the content of bioac-

An asterisk (*) in front of a name indicates the presenting author.

tive compounds in kale plants.

Comparisons of Lettuce Grown in Aquaponics and Hydroponics *(Poster Board #170)*

Teng Yang*; Yi-Ju Wang; Gaotian Zhu and Hye-Ji Kim, Purdue University

Aquaponics is an emerging sustainable production system that integrated the hydroponic crops and fish production. It has been arousing worldwide attention because of its environment-friendly practices promoting aquaculture wastewater recycling and reducing hydroponic fertilizer input. However, scientific knowledge is limited for the development of commercial aquaponics and improvement of plant production. Thus, this study was conducted to compare the dynamic growth of aquaponics and hydroponic grown crops. Three aquaponics units and three hydroponics units were used. Lettuce was used as a model plant, chosen for its short growing season with a high yield. Lettuce (*Lactuca sativa*) and Nile tilapia (*Oreochromis niloticus* L.) were cultured with a density of 24 plants/m^2 for lettuce and 11kg/m^3 for fish stocking. This study was conducted for 4 weeks and repeated twice. Water pH and temperature were maintained at 6.5 and 23^0C in both aquaponics and hydroponics. Electrical conductivity (EC) level was maintained at 1.5 mS/cm for hydroponic system by adding commercial fertilizer, while EC increased from 1.03 to 1.47 mS/cm in aquaponic system. Photosynthetic rate, SPAD value, Fv/Fm, crop fresh weight and dry weight, root structure and other morphological parameters were measured every three days. Water quality including water temperature, EC, pH, and dissolved oxygen (DO) was monitored daily. Water samples were gathered every three days for ionic nutrient measurement. Nitrifying bacteria were measured every week. During the whole study, no fish died or showed abnormal growth pattern in aquaponics system, and the population of nitrifying bacteria was and did not fluctuate (7×10^6 copies number/50 mL) over time, which indicated a suitable and stable growth environment. Although higher EC level in hydroponics, aquaponics grown lettuce showed no significant difference in terms of plant morphological appearance (plant height, leaf length, leaf number and leaf area) and fresh weight based on three-day interval, and showed significantly higher root and leaf dry weight in the final harvest. Interestingly, lettuce in aquaponics recovered faster from transplanting stress (higher Fv/Fm) than that in hydroponics. In addition, in the final week of lettuce growth, aquaponic-grown lettuce showed significant higher photosynthesis rate and SPAD value. The result of this study could provide critical information to enhance aquaponics-grown crop production in the large-scale commercial production market.

The Growth and Yield of Vegetable Crops Are Affected By Water Flow-Rate in Aquaponics Systems *(Poster Board #171)*

Teng Yang* and Hye-Ji Kim, Purdue University

Aquaponics is an emerging sustainable production system, which creates a closed-loop ecosystem for fish, microbes, and plants. As water is critical to recycle ionic nutrients and oxygen in the production loop, its movement and the rate of turnover require optimization to ensure good water quality and growth environment for both of fish and crops. Although FAO guideline for densely-stocked aquaponic systems is to cycle the water two times each hour, it is still doubtful whether this turnover rate is necessary in aquaponics at low stocking densities or planted with plants have high ability to uptake nutrients. Therefore, water flowrate and crop growth potential were evaluated as factors determining water quality and cash crop yields in aquaponic system. Six vegetable crops with different growth rates were cultured in tilapia-based aquaponics systems, which include two fast-growing crops, Chinese cabbage (*Brassica rapa*) and lettuce (*Lactuca sativa*); two medium-growing crops, mustard (*Brassica juncea*) and chia (*Salvia hispanica*); and two slow-growing crops, basil (*Ocimum basilicum*) and Swiss chard (*Beta vulgaris*). Flow rate treatments were low (1000 L/day, LFR), medium (2000 L/day, MFR), and high (3000 L/day, HFR) flow rate. Fish were fed once a day by 1% fish fresh weight. Water quality parameters were measured daily. The pH was adjusted at around 7. Water was sampled for total ammonium nitrogen (TAN), nitrite, nitrate, and phosphate measurements every three days. Photosynthetic rate (Pn) and leaf temperature were measured. At the beginning and harvest, crop and fish growth parameters were measured. This study was conducted for 4 weeks and repeated twice. Data showed that flow rate was negatively correlated with water temperature and electricity conductance. In addition, nitrate, phosphate and sulfate levels showed significant negatively correlation with flow rate, indicating a higher nutrient removal of crops at HFR. Lower EC (better water quality) at HFR also enhanced fish production. Crops grown at HFR showed higher SPAD value, photosynthetic rate, stomatal conductance, transpiration rate and total nitrogen content. Interestingly, HFR increased the fresh and dry mass of slow-growing crops, while no significant difference was found between HFR and MFR for fast-growing and medium-growing crops. It was concluded that flow rate at 3000 L/day is sufficient for the growth and yield of crops regardless of growth rate, and flow rate can be lowered to 2000 L/day for fast-growing crop species.

Effects of Different pH for Basil in Coupled Aquaponics System *(Poster Board #172)*

Gaotian Zhu* and Hye-Ji Kim, Purdue University

Along with world population increasing, reaching 9 billion in 2050, food demand becomes a huge concern around the world. Besides, increasing population and fast growing industrialization lead environment problem becoming more obvious and serious. Fish is an important protein source for human daily consumption, but rising fish causes a lot of wastes polluting our environment. It is not sustainable if fish waste were simply dumped away, since fish waste contain high nitrogen which can be uptake by plants. Aquaponic system as the combination of hydroponic production, aquaculture and bacteria has ability to convert fish wastes to nutrients for plants, as well as purify water simultaneously to provide both fish and edible plants for human needs. Typically, aquaculture specialist set pH 7 for coupled aquaponic system, because nitrifying bacteria can have better activity in pH range 7.2-7.8. Fish wastes contain ammonia (NH_3), and optimum living condition helps nitrifying bacteria to convert ammonia to nitrate (NO_3^-) which can be used for plants growth. In my experiment, three aquaponic system and three hydroponic system were used by setting pH as 6, 6.5 and 7 respectively. EC was maintained as 1.548±0.13 mS/cm, DO was maintained as 7.91±0.39 mg/L, and temperature was maintained as 22.106±0.684°C for all pH treatments. Feeding rate was set as 1% biomass/day, and fishes were weighed every week to determine daily feeding amount accordingly. The whole experiment last one month. In result, in terms of leaf FW, aquaponic pH 6 showed 34.41% higher than aquaponic pH 6.5 and 34.78% higher than aquaponic pH 7. Similarly, aquaponic pH 6 showed 49.77% and 52.87% higher than pH 6.5 and pH 7 in leaf DW. Interestingly, in aquaponic system, pH 6 showed best FW and DW for leaf, stem and root of basil. Besides, aquaponic pH 6 showed no significant difference with hydroponic pH 6, except for FW stem and DW root. Hydroponic pH 6 showed significant higher FW stem than aquaponic pH 6. However, aquaponic pH 6 showed 47.22% higher DW root than hydroponic pH 6. Aquaponic pH 7 showed best fish growth, and pH 6 average fish weight was 12.57% lower. Overall, when considering about plants growth in coupled aquaponic system, pH 7 might not be a good choice, because pH 6 showed significant higher yield than pH 7. Based on the experiment, farmers can set pH wisely in coupled aquaponic system, since pH 6.5 toward 6 is better for plants to grow. High profit and short life cycle plants can be used in the system for higher return on investment. Further investigation of this study could determine effect of different pH setting for various plants species.

Peat-Based Substrates Containing Ground Parboiled Rice Hulls Reduce Water Use and Maintain Quality of Petunia and Zinnia *(Poster Board #173)*

Seunghyun Choi*, Purdue Univeristy and Hye-Ji Kim, Purdue University

This study was conducted to provide a holistic view on the effects of substrate properties on the growth and water use of *Petunia* 'Easy Wave Neon Rose' and *Zinnia* 'Benary's Giant Golden Yellow'. Our objectives were 1) to identify ideal blends of parboiled rice hulls (PRH) by determining the physical and chemical properties of PRH-containing substrates using either parboiled ground rice hulls (GRH) or whole rice hulls (WRH), and 2) to evaluate how such properties affect the growth and water use of plants grown in the substrate mixtures. Fourteen growing substrates were formulated by blending 0%, 20%, 30%, 40%, 50%, 60%, or 70% GRH or WRH (by volume) with the remainder being peat, 20% perlite and 10% vermiculite. Physical and chemical properties were determined and compared with commercial potting mix (CPM: 70% peat, 20% perlite and 10% vermiculite). Inclusion of either GRH or WRH in the peat-based substrates increased total porosity (TP), air space (AS), and particle density (PD), but decreased water holding capacity (WHC). Physical parameters of GRH were similar to CPM at the mixing rate of 20% to 50%. The pH and EC increased as the percentage of PRH increased, but were significantly lower than those of CPM at 60% or lower mixing rate. Based on the results, the peat-based substrates containing 40% GRH (GRH-40) and 40% WRH (WRH-40) were identified as the ideal mixes for the plants evaluated in this research, and selected for plant growth and water use study. Each plant was grown in a pot containing CPM, GRH-40 or WRH-40 maintained at two different volumetric water contents (VWC): high (25% to 30% and 20% to 25% in both CPM and GRH-40) and low (15% to 20% and 10% to 15% in WRH-40). Water use of plants rapidly increased from 3 weeks as their size increased. Petunia required significantly less volume of water compared to zinnia in a given time period. Initial growth reduction was observed in petunia and zinnia grown in the substrates of GRH-40 and WRH-40, and at a higher reduction rate in zinnia, particularly when grown in WRH-40. This led to a significant decrease in plant biomass of WRH-40 grown zinnia at 7 weeks, compared to the CPM or GRH-40 grown plants. Low VWC more negatively affected the growth of plants in CPM than in GRH-40. Plants grown in GRH-40 were compact and produced marketable quality products similar to those grown in CPM, while using significantly less volume of water to maintain the target ranges of VWC. Our results show that substrates are one of the major factors affecting plant water use, and the peat-based substrates containing 40% GRH can be utilized for the production of petunia and zinnia using less irrigation water, without compromising plant growth.

Specified Source(s) of Funding: NE-1335

Vegetal-Derived Biostimulant Enhances Adventitious Rooting in Cuttings of Chrysanthemum Via Brassinosteroid-Mediated Processes *(Poster Board #174)*

Seunghyun Choi*, Purdue Univeristy and Hye-Ji Kim, Purdue University

Plant-derived protein biostimulants exhibit hormone-like activities promoting plant growth and yield, yet detailed investigations on hormonal function have remained limited. This study was conducted to investigate the effects of vegetal-derived-biostimulant on morphological and metabolic changes in cuttings of chrysanthemum (*Chrysanthemum indicum* L.) demonstrating different rooting ability in comparison to brassinosteroid and auxin. Unrooted cuttings were applied with or without biostimulant (1, 5, 10, 15, 20, and 30 mg L^{-1}), Brassinosteroid (24-Epbrassinolide;, 0.5,1, 2, 5, 10, and 15 **μ**M) or auxin [1% indole-3-butyric acid (IBA) plus 0.5% 1-naphthaleneacetic acid (NAA); 200 mg L^{-1}] as a basal quick-dip, stuck into inert media, and evaluated at 20 days after placement under intermittent mist. Biostimulant required a significantly higher threshold for a series of adventitious rooting responses than auxin, and the maximum effectiveness was achieved at 1 mg L^{-1} for biostimulant and between 5 and 10 **μ**M for brassinosteroid. Adventitious rooting responses (dry mass and length) to biostimulant showed a gradual logarithmic rise as a function of increasing dosages, which was not in agreement with biphasic dose-response of auxin. Biostimulant significantly increased or tended to increase fine roots in the tested cuttings, which was not consistent with auxin. The results of cuttings with brassinosteroid are not significantly different from those of biostimulant. These results indicate that the hormonal effects of vegetal-derived biostimulant are primarily exerted by BR-mediated processes while involving interaction with auxin.

Specified Source(s) of Funding: NE-1335

Enhancement Crop Yield and Quality By Plant Growth-Promoting Bacteria in Aquaponics *(Poster Board #175)*

Yi-Ju Wang*; Sahar Abdelrazek; Lori Hoagland and Hye-Ji Kim, Purdue University

Aquaponics, a growing trend in food production, integrates aquaculture and hydroponics into one system. In aquaponics, bacteria function as biofilter to convert ammonia into nitrite and nitrate, plants absorb mineral nutrients from aquaculture wastewater and then the purified water returns to the fish tank. Aquaponics offer a promising solution for sustainable food production by reducing the usage of water and chemical fertilizers and has great potential to be one of the most promising food production systems, particularly for rapidly growing urban population. However, our results showed that crops grown in aquaponics had consistently lower yield and quality compared to those grown in hydroponics. Many studies on aquaponics have focused on improving nitrifying bacterial activities for faster conversion of harmful ammonia to nitrate, for which the suggested pH for aquaponics is 7. However, we found that plants can better perform and have higher yield in the range of pH 6 to 6.5. These results indicate that nitrifying bacteria may not be the key microbes in aquaponics, but there are other bacterial groups playing a key role affecting crop growth and yield in aquaponics. The largest bacterial phylum in aquaponic solution is reported to be Proteobateria, which consists of many different plant growth-promoting bacteria (PGPB). In this study, we hypothesized that plant growth-promoting bacteria (PGPB) are the key players in aquaponics by protecting them from abiotic stress such as high salinity and ammonia and nitrite stress and pH ranges of 6 to 6.5 may encourage their growth. As an initial step, we used different *Psudomonas* spp. isolates to identify which isolate enhances root elongation and salinity tolerance of Arabidopsis. As a second step, we inoculated potential PGPB on roots of lettuce seedlings and transplanted lettuce into aquaponic systems to compare crop performance in comparison to control plants. Key outcomes are expected to identify the role of PGPB in aquaponics systems. Our research will provide critical information to increase aquaponic crop production in the large-scale commercial operation.

Plant Nutrient Management 1 (Poster)

Real-Time Data from Portable Technology Helps Guide Sustainable Growth of Healthy Plants

(Poster Board #154)

Kimberley Russell*, Bruker

Real-time data on elemental nutrients and heavy metals in native soil, fertilizers, treatments and their uptake by plants is of great value to horticulturists striving to optimize the growth of healthy, local and sustainable fruits, vegetables and herbs.

Nutrients (e.g., P, K), secondary nutrients (e.g., Ca, Mg, S) and micro nutrients (e.g., Cu, Fe, Mn, Mo, Zn) in natural or manufactured agents allow plants to develop into large, appetizing and healthy products. Conversely, heavy metals (e.g., As, Cd, Hg, Pb) present in outdoor or indoor growth media can damage plants and develop hazardous products.

With today's interest in both sustainable and precision agriculture of healthy foods, many organizations now monitor the growth media and plant uptake of nutrients and heavy metals using portable X-ray fluorescence (pXRF) spectrometry. This elemental analysis method is nondestructive and can be taken into the field or greenhouse to rapidly screen soil, powders, liquids, solids and plant tissue for fast actionable results.

PXRF has long been used for elemental analysis of soils for environmental stewardship as well as for geological studies such as mineral exploration. Two well-known environmental methods for this application are US EPA 2007 SW-846 Test Method 6200 and ISO 13196:2013. Additionally, the "USDA Soil Survey Field and Laboratory Methods Manual (2014, No. 51, V.2)" describes the pXRF method for major and trace elemental analysis in the "Soil Mineralogical Analyses" section.

Real-time nutrient diagnostics and heavy metal screening with portable elemental analyzers help horticulturists optimize plant characteristics and maintain product safety at any stage of the growing cycle. This capability enables growers to make better decisions about their plants' progress in real time without having to send large quantities of samples out to a lab.

The technology of pXRF will be described; the trade-offs between screening samples as-is and analyzing samples which have been prepared will be discussed; and data correlated with ICP analysis will be presented.

Hot Pepper Responses to Single-, and Multi-Nutrient Fertilizer Sources *(Poster Board #155)*

John Jifon*, Texas A&M AgriLife Research Center

Yield response of chili peppers (*Capsicum annuum L.*, cv 'TAM Mild Jalapeño II') to three potassium fertilizer sources: (i) muriate of potash (MOP; 60% K_2O), (ii) sulfate of potash (SOP, 50% K_2O, 17% S), and (iii) polysulfate (PS; an organic multi-nutrient fertilizer containing sulfur, potassium, calcium and magnesium as 14% K_2O, 17% CaO, 6% MgO and 48% SO_4) were investigated in greenhouse studies (spring and fall 2017) using a local calcareous potting soil. All fertilizer sources were applied at four equivalent K_2O rates (50, 100, 150, and 200 kg·ha^{-1}). Fruit yield and yield components (average fruit mass, number of fruits per plant, dry matter content) were significantly increased by K fertilization ($P<0.001$) in both seasons; however, yields were generally higher in the spring study (average 19 mT·ha^{-1}) compared to fall (average 55.5 mT·ha^{-1}) possibly due to a relatively shorter growing season and cloudy weather conditions during the fall study. In in both studies, yields were higher for all rates above the 50 kg·ha^{-1} rate. Fruit number per plant was higher with PS and SOP than control and MOP treatments. Average seed mass per fruit was increased by fertilization but this was also significant only with SOP and PS treatments at the 150 and 200 kg·ha^{-1} rates. Fruit firmness and dry matter content generally increased linearly with K_2O application rates ($P<0.01$) with a slightly higher responses observed with PS and SOP than with MOP. Post-harvest soil analysis indicated slightly lowered soil pH in PS and SOP treatments and lower sodium concentrations in PS treatments. The results suggest that multi-nutrient fertilizer sources such as PS have potential yield and quality benefits for organic crop production and better nutrient use efficiencies, perhaps due to synergies resulting from different nutrient components.

Influence of Nutrient Solution Concentration on Growth and Tissue Mineral Content of Korean Ginseng Seedlings Cultured in Root Substrates Containing Peat and Perlite *(Poster Board #156)*

Jong-Myung Choi*[1]; Hyung Bum Park[1]; Sang Yong Park[1] and Chiwon W. Lee[2], (1)Chungnam National University, (2) North Dakota State University

Ginseng production in Korea involves three cultural phases: seed germination and seedling culture during the first year, transplanting of the one-year old seedlings to well-prepared soil beds that are amended for desirable fertility and physical property, and culture of the plants under shade for 4-6 years until harvest. While seedlings were raised on mineral soils under shade outdoors, there is an increasing trend now of producing seedlings in amended root substrates in raised beds in the greenhouse. Precise control of fertility for root substrates is essential for raising healthy seedlings especially when inert media with low buffering capacity are used. Reports in this area of research for ginseng is largely lacking. The objective of this study was to investigate the influence of fertility (as measured by EC) of the nutrient solution used for seedling production. The raised beds of 120 x 60 x 25 cm (length x width x height) were filled with root substrate composed of peat moss + perlite (7:3, v/v) and cold-stratified seeds were sown on Mar 9, 2018 (300 seeds per treatment, 3 cm x 3 cm spacing). After seed germination, fertigation of the beds started on May 21 using each of six nutrient solutions containing 0.4, 0.6, 0.8, 1.0, 1.2 dS·m^{-1} EC prepared with ground water (0.25 dS·m^{-1}) and fertilizer stock solutions. The pH of all solutions was adjusted to 5.8±0.5 and the stock solution contained (mM): 2 NH_4^+-N, 12 NO_3^--N, 1 $H_2PO_4^-$, 8 K^+, 2 Ca^{2+}, 1 Mg^{2+}, 1 SO_4^{2-}. Fertigation frequencies were controlled using the GS-3 soil moisture sensor and treatment solutions were automatically supplied 30 minutes when volumetric water content decreased to 36% (amounts of supplied solution per treatment were 0.4-0.45 L and 20-30% of supplied solutions were drained). The measurements of plant growth and tissue and soil analyses were made twice: first on July 31 and 2nd on Sept 21. For the first growth measurement, elevating EC in fertilizer solution resulted in enhanced growth, but statistical differences among treatment solutions, except ground water (EC 0.25), were not significant. In the second measurement, the seedling growths in terms of dry weight of above- and below-ground plant parts increased significantly when solution ECs were elevated up to 1.0 dS·m^{-1} but decreased again at 1.2 dS·m^{-1} treatment. In both the 1st and 2nd measurements, the mineral tissue nutrient contents of T-N, P, K and Ca were different significantly among treatments, while tissue contents of other elements were unaffected by treatments. The T-N and P contents of roots were higher than those of the above-ground plant parts, but the Ca content of the above-ground tissue were 11 to 14 times higher than those of the root tissues. The EC of root media in the 1.0 dS·m^{-1} treatment, in which the seedling growths were the highest among treatments, were 0.54 dS·m^{-1} during the 1st measurement time and 0.82 dS·m^{-1} during the 2nd measurement time. In summary, the adjustment of nutrient solution EC to 1.0 dS·m^{-1} was desirable for best growth of ginseng seedlings when a mixture of peat moss + perlite (7:3, v/v) was used as root medium and leaching percentage was adjusted to 20-30%.

Assessing Soil Responses to Various Land Management Practices *(Poster Board #157)*

Iin Handayani*; Carrie Ann Followell and David Ferguson, Murray State University

Land management systems and alteration of the ecosystem can significantly affect soil quality indicators such as physical, chemical, and biological properties. In this study, changes in soil organic carbon (SOC), water stable aggregates (WSA), soil pH, soil moisture and particulate organic matter C (POM-C) were examined in two contrasting management practices (no till vs conventional tillage with and without cover crops). Soil samples from no tillage (NT) and conventional tillage (CT) plots were collected from the depth of 10 cm and 20 cm in Calloway County, Kentucky in 2018. Three types of cover crops being evaluated include wheat, cereal rye, oats and radish and a control with no cover crop. Findings show that SOC in the no till systems ranged from 2.4-2.9% while the conventional till systems ranged from 1.8-2.8%. The macroaggregates varied largely with the conventional till system with no cover crop containing the most in both depths. The ratio of macro-to-microaggregates in both tillage systems was fairly equal with exceptions to no till cereal rye and conventional till system with no cover crop. Conventional till with no cover crop appears to have the highest ratio of macro- to microaggregates. The ratio of POM C to SOC remained mostly equal and steady across all samples, averaging 35% for all. The highest POM C was found in conventional till systems at average of 0.96% and the lowest was observed in cereal rye no till systems at both depth intervals with 0.64%. The soil pH ranged from 5.8-7.4 for the no till systems and 6.8-7.4 for the conventional till systems. No till systems with cereal rye had the lowest soil pH of 5.8 at depth 10-20 cm. There is no significant effect of tillage systems and cover crops on soil moisture content at air dry soils. The results of this study are important to predict the benefits of the combination effects of tillage and cover crops on soil quality changes.

Keywords: Cover crop, Macro-aggregates, No till, Organic carbon, Particulate organic matter

Specified Source(s) of Funding: McNair Program

Effect of Humic Acid on Lettuce Growth, Plant Nutrients, and the Soil Microbiome *(Poster Board #158)*

Jaime Barros da Silva Filho*, University of California Riverside

Humic acid refers to a group of compounds produced during the breakdown of organic matter that may improve plant productivity and soil structure. As interest in soil health and organic agriculture have increased, so has interest in humic acid. We measured the response of lettuce and soil to humic acid applications in a field experiment. Humic acid increased the concentrations of some micro- and macronutrients in lettuce tissue but had variable effects on yields. The effect on the soil microbiome was most striking, with an increased humic acid application rate being directly related to microbial population number and diversity. Humic acid applications increased the relative abundance of several species of bacteria involved with nutrient cycling and availability.

Evaluation of Stover Removal & Fresh Mushroom Compost on Corn Yield and Soil Quality *(Poster Board #159)*

Phillip Coles*[1]; Galina Nogin[2]; Michael A. Fidanza[3] and Greg Roth[3], (1)Lehigh University, (2)Cornell University, (3) The Pennsylvania State University

Mushroom producers are continually looking for new substrate (compost) raw material sources and pathways to dispose of mushroom compost (formerly called "Spent Mushroom Substrate") after crop completion. A relatively new material used in the mushroom industry is corn stover, but supplies are somewhat limited. Corn farmers are often reluctant to remove stover from fields because of nutrient loss and possible soil erosion due to reduced soil protection. Mushroom compost is a potential substitute for stover that can provide these same benefits. In this study we evaluate the potential to improve corn crop yield and soil quality through stover removal coupled with the application of fresh mushroom compost. We removed stover in varying amounts and replaced it with mushroom compost at several rates in order to find the optimal rate for both, and to provide a rationale to replace stover with mushroom compost in order to generate additional income for corn farmers, and increase substrate component availability and mushroom compost disposal alternatives, to the mushroom industry.

Specified Source(s) of Funding: Pennsylvania Department of Agriculture Research Grant through the Mushroom Farmers of Pennsylvania Committee of the American Mushroom Institute

Labile Soil Organic Carbon and Soil Enzymes in Chili Pepper Production As Affected By Living Mulches and Nutrient Management *(Poster Board #160)*

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Cambodia's population has increased by 1.5% per year and remains among the fastest-growing regions in Asia. Continuing population growth, suggesting that there will increase competition for land, water, and nutrients to meet the simultaneously rising demand for food. Soil Organic Carbon (SOC) plays a crucial role in enhancing crop productivity through carbon sequestration and soil microbial biomass. The decline of SOC causes poor aggregation, accelerates soil erosion and reduces soil biological and enzymatic activities. SOC can be enhanced by addition of biomass-C inputs such as crop residue on the soil surface, root biomass of living mulch, and the absence of soil disruption. Meanwhile, crop productivity could also be enhanced by proper nutrient management practices. Our research study aims to investigate the effects of different soil mulching and soil nutrient management on SOC and its fraction and soil enzyme activities. This research is conducted at two locations (Battambang and Siem Reap province) with different soil texture for three cropping cycles. Our hypothesis is that the inputs of different soil mulching (i.e. *Arachis pintoi,* Morning Glory, and Rice straw) and soil nutrient management (cattle manure, UREA fertilizer, manure + UREA fertilizer) in a short-term management practices could increase the soil labile carbon and enzymatic activities compared to non-mulching in chili pepper production. The experimental plots are laid out in spit plot with two factors. Soil mulching treatments serve as main plots and soil nutrient management treatments serve as sub-plots. The Composite soil samples will be collected following three cycles cropping system at four depths: 0-5, 5-10, 10-20, and 20-40 cm depths. Soil samples will be air dried, sieved and analyzed for Hot-water extractable C – HWEOC, permanganate oxidizable C – POXC, chemically stabilized organic C-CSOC, Dehydrogenase, β-glucosidase, β-glucosaminidase, and Phosphatase. We expect that using of soil mulching (legume living mulch, non-legume living mulch, and crop residue) and nutrient management (manure and/or inorganic fertilizer) which are under conservation tillage will improve SOC and its fraction and soil enzyme activities, while treatment of non-legume without fertilizer will reveal in the lowest results of SOC and its fraction.

Keywords: β-glucosidase, Living mulch, Hot-water extractable C, permanganate oxidizable C, inorganic fertilizer, manure, Dehydrogenase

Specified Source(s) of Funding: Feed the Future Horticulture Innovation Lab

Produce Quality, Safety, and Health Properties (Poster)

Impact of Supplemental UV on the Accumulation of Mineral Nutrients and Phytochemicals in Lettuce *(Poster Board #401)*

Myungjin Lee*[1]; Jin-hui Lee[2]; Myungmin Oh[2]; Jungkwun Kim[1] and C.B. Rajashekar[1], (1)Kansas State University, (2) Chungbuk National University

Very little is known with regard to the effects of ultra violet (UV) light on the nutritional quality of crops, especially as it relates to the health-promoting phytochemicals. In this study, we examined the effect of supplemental UV using conventional and LED sources on the nutritional quality of lettuce (*Lactuca sativa* L., red-leaf variety 'New Red Fire' and green-leaf variety 'Two Star'). The plants were grown in a greenhouse and subjected to UV-A, UV-B and UV-A+B (8.11, 1.97 and 5.08+1.55 W/m^2, respectively) using conventional source (fluorescent tubes) one week prior to harvest. In a separate experiment, plants were grown in a growth chamber set at 22^{o}C with a PPFD of 244 umol.m^{-2}.s^{-1} (PAR) for 12 h and were subjected to various LEDs equipped with filters to modulate the dispersion of radiant energy one week before harvest. The LED treatment included standard LED and LED with 5-degree lens and LED with scatter lens with mean irradiance of 1.11W/m^2. UV LED treatments did not show a consistent impact on the accumulation of mineral nutrients and phytochemicals. Use of specific wavelengths of UV (375 and 395 nm) as a supplemental source also did not have a significant impact on the nutrition quality of lettuce. However in contrast, conventional source of UV had significant effect on the accumulation of mineral nutrients and phytochemicals. N accumulation in the leaves of 'Two Star' was increased by the exposure of plants to UV-A and UV-B while carbon accumulation was increased by UV-A but was depressed by the exposure to UV-B. In addition, the accumulation of many mineral nutrients such as Ca, Mg, Cu, Mn and Zn were enhanced by exposure to UV-A and UV-B in both varieties. With regard to phytochemical accumulation, UV-A had a stronger response in the red-leaf lettuce variety ('New Red Fire') as illustrated by higher accumulation many flavonoids including luteolin 7-glucoside, apigenin 3-glucoside and quercetin 3-glucoside. UV-A treatment generally increased both the total phenolic content and the antioxidant capacity in the leaves of 'New Red Fire.' The results show that conventional source of UV has significant positive impact on the nutritional quality of lettuce and particularly, UV-A which can enhance the accumulation of several flavonoids in the leaves of red-leaf lettuce variety.

The study was supported by a grant from USDA-NIFA.

Specified Source(s) of Funding: USDA-NIFA

Low Red to Far-Red Light Ratio Maximizes Glucobrassicin Concentration in 'Ruby Ball' Cabbage (*Brassica oleracea*) Heads *(Poster Board #402)*

Ilse Renner*, University of Minnesota

Phytonutrients may play a key role in prevention of certain slow to progress diseases like cancer. Epidemiological evidence supports the inverse relationship between certain cancers and the consumption of cruciferous vegetables which contain glucosinolates – phytonutrients produced almost exclusively in the *Brassicaceae* family. Furthermore, lab studies have demonstrated chemopreventive roles of certain glucosinolates. Production systems that enhance phytonutrient concentrations could deliver products that benefit producers and consumers. The red to far-red (R:FR) light ratio is known to affect glucosinolates; although how it impacts individual glucosinolates within specific cultivars is not well understood. R:FR is important in a field setting as it can be dramatically influenced by shading and reflectance from nearby plants as well as in controlled environments where the light source can be attuned to maximize phytonutrient concentrations.

This research examines R:FR effects on the concentration of the particularly chemopreventive indole glucosinolate, glucobrassicin. We grew 'Ruby Ball' and 'Tiara' cabbage (*Brassica oleracea* var. capitata) in a split-plot design in a high-tunnel in spring and fall of 2016 and 2017 in Grand Rapids, MN. Plants were subjected to various durations of weed competition (consisting of eight different treatments) which altered R:FR within the canopy. Light spectra were taken weekly in order to relate the treatments to changes in R:FR. Soil moisture was never limiting and nitrogen was applied as a split application to minimize nutrient competition. Glucobrassicin concentration in 'Ruby Ball' was maximized in treatments of high competition, which was in part driven by R:FR reduction caused by dense vegetation ($R^2 = 0.51$; $p<0.001$). Analysis of variance showed treatment differences ($p<0.001$), and the treatment with the longest duration of weed competition resulted in the highest glucobrassicin concentration in the head tissue compared to a weed-free control (89.0 vs 43.8 µmol $100g^{-1}$ fresh weight respectively). Other treatments resulted in intermediate concentrations and displayed a general positive relationship between competition and glucobrassicin concentration. Growth rate was not a significant contributing factor. Similarly, 'Ruby Ball' grown in a growth chamber under R:FR of 5.0, 1.1, and 0.3 showed that glucobrassicin concentration was highest in head tissue in the 0.3 R:FR treatment which resulted in over two times the concentration compared to the other two treatments (24 vs 10 and 9 µmol $100g^{-1}$ fresh weight for 0.3, 1.1, and 5.0 R:FR treatments respectively). This data suggests that R:FR manipulation affects glucobrassicin in 'Ruby Ball' cabbage heads in high-tunnels and controlled environments.

Specified Source(s) of Funding: University of Minnesota

Nutritional Quality of Alaska Grown Produce

(Poster Board #403)

Meriam Karlsson*, University of Alaska Fairbanks

The nutritional content of fresh produce available to consumers in stores, at farmer markets or locally grown was evaluated in Fairbanks, Alaska. The study was conducted to determine potential differences between locally grown produce and produce available in local stores from various sources. The included vegetable crops were tomatoes, colored bell peppers, English cucumbers, kale, butterhead- and romaine lettuce. Samples were collected throughout the summer months when vegetables were locally produced and available. Analysis for mineral nutrition included nitrogen, phosphorous, potassium, calcium, magnesium, sulfur, iron, manganese, boron, copper and zinc. Brix analysis were used to determine levels of soluble solids and sugar content. Although the nutrient content varied among vegetables procured from stores, farmers markets or locally grown, the mineral levels within a particular crop were less variable. The highest amounts in percent of dry weight for nitrogen (5.0 ± 0.60), phosphorous (0.7 ± 0.27) and potassium (5.8 ± 1.75) were recorded for butterhead- and romaine lettuce. Iron content was also significantly higher with more than 200 ppm in the two types of lettuce. The analysis showed produce grown locally or obtained from the farmers market generally had greater °Brix values to suggest higher sugar content than produce from local stores. The °Brix value for locally grown red bell peppers for instance, was 8.7 ± 0.68 compared to 5.5 ± 0.36 for a similar store bought pepper. As public awareness of nutrition and food security is increasing, documenting and evaluating the nutrient content of locally available produce is becoming more important for consumers as well as producers. To further evaluate nutrient content of locally grown versus produce derived from out of state sources, additional studies are being conducted.

Phenolic and Antioxidant Comparison of Aronia (*Aronia prunifolia*), Blueberry (*Vaccinium corymbosum*), Blackberry (*Rubus* spp.) and Raspberry (*Rubus idaeus*) Grown at Virginia State University *(Poster Board #404)*

Rafat Siddiqui; Haiwen Li; Christos Galanopoulos* and Reza Rafie, Virginia State University

The rise of a health-conscious population has increased the demand for healthy foods. One such food is berries which includes aronia (*Aronia prunifolia*), blueberry (*Vaccinium corymbosum*), blackberry (*Rubus* spp.) and raspberry (*Rubus idaeus).* In 2018, these berries were harvested at Virginia State University Randolph Farms and stored in a freezer. In January of 2019, samples were desiccated. Three lab tests were conducted on each of berry samples: a total phenolic content analysis, a DPPH assay, and an ABTS antioxidant assay. In all three of the tests, aronia berries produced the highest antioxidant activity and phenolic content with a significant statistical difference (p-value 0.001). Blackberry, had higher antioxidant and phenolic level than raspberry and blueberry. Raspberry showed significant difference with blueberry only at the DPPH assay. Thus, while aronia had the highest phenolic and antioxidant activity, blackberry also qualified as a healthy berry with antioxidant properties for health-conscious consumers.

Specified Source(s) of Funding: Extension Funding from the Comonwealth of Virginia

Use of Gamma Irradiation As an Intervention Treatment to Inactivate Escherichia coli O157:H7 in Freshly Pressed Apple Juice *(Poster Board #405)*

Dielle Fernandes*, Chapman University

Escherichia coli O157: H7 can contaminate dropped apples used for juicing via manure or irrigation water and attach to the flesh of the apple through bruises and wounds where surface sanitizers are not effective. The goal of this project was to determine the efficacy of gamma irradiation at the maximum allowed dose of 1kGy to inactivate *E.coli O157: H7* in whole apples used for juicing. Whole apples were punctured to simulate wounds which were then inoculated with an outbreak strain of *E.coli O157: H7* and subjected to gamma irradiation at doses upto 1 kGy. The D-value of the *E.coli O157: H7* strain was 334 kGy indicating that irradiation at 1 kGy would result in a 3-log reduction of this pathogen . Contaminated apples were also stored for 3 weeks in cold temperatures during which *E.coli O157: H7* survived but did not grow. The inoculated apples were juiced, and the juice was stored upto 72 hours. There was no change in counts of *E.coli O157: H7* in the juice from the control apples, but irradiation at 800 Gy reduced counts by 3 logs, and these cells did not survive the 72 hour storage. Sensory testing of juice treated at 1000 Gy indicated that consumers could tell the difference from control juice, due mostly to greater sweetness of the juice from irradiated apples. These results show that *E.coli O157: H7* can easily survive in bruised apples and the juice made from them. Irradiation can provide significant lethality of *E.coli O157: H7* in apples and juice conferring a greater level of safety without negative effects on sensory quality.

Effect of Low Dose Irradiation on Expression of Genes Involved in Ethylene Biosynthesis of 'granny Smith' Apples *(Poster Board #406)*

Brian Nyakundi*; A. Prakash; Hagop Atamian and Paul Olabode, Chapman University

Superficial scald is a physiological disorder characterized by skin browning that appears during or after storage of 'Granny Smith' apples. Currently, the disorder is controlled by reducing a-farnesene oxidation with antioxidant diphenylamine (DPA). The mechanism for scald development is not fully understood, but it is hypothesized that scald formation is related to increased ethylene production. In apples, low dose irradiation induced ethylene reduction appears to be directly related to prevention of superficial scald. However, the molecular basis of such an irradiation-induced effect is not known. In this study, effort was made to better understand the molecular basis of the decrease in superficial scald and ethylene production in 'Granny Smith' apples after treatment with gamma irradiation. Apple fruit were exposed to radiation treatment either at 310 Gy or 1000 Gy and ethylene production, ACC oxidase enzyme activity and expression of the genes responsible for ethylene biosynthesis were measured after 0, 90, and 180 days of storage. Ethylene production of irradiated apples was lower compared to control. No difference was observed in ACC oxidase activity at day 0, but irradiation at 310 Gy and 1000 Gy reduced enzyme activity at days 90 and 180. In contrast, increased expression of ACC oxidase 1 (ACO1) and ACC oxidase 2 (ACO2) was observed at day 90 for apple fruit treated with radiation at 310 Gy. ACC synthase 3 (ACS3) was not significantly affected by radiation treatment. Gene expression did not correlate with ethylene production or ACC oxidase enzyme activity. Our results indicate that irradiation had different effects on gene expression and enzyme activity, and subsequently ethylene production. Additionally, factors other than gene expression affect ethylene biosynthesis.

Vegetable Breeding 2 (Poster)

Cosmetic Stay-Green in Snap Bean: Understanding Deleterious Effects on Germination and Emergence *(Poster Board #266)*

Melike Cirak*; Kathy Cook and James R. Myers, Oregon State University

For snap bean (*Phaseolus vulgaris*L.) production, white-seeded cultivars are mostly used because colored seed results in anthocyanins in the seed and pods that impact visual appearance and reduce quality of the processed product. Some snap bean cultivars have been released with *persistent color (pc)*, a member of the cosmetic stay-green gene family. These types are considered more desirable because the trait imparts a uniform dark green appearance to the pods. However, *pc*seeds show reduced germination and emergence compared to white-seeded types. Pleiotropic effects of *pc*are that dry seed is pale green in color, germinating seedling have bleached white cotyledons, and plant foliage and pods remain green even while senescing. Currently, *pc*cultivars comprise about 40% of commercial acreage in the U.S. Seed fungicide treatments increase germination and emergence rates to levels almost the same as fungicide-treated white seed. The number of *pc*cultivars would likely increase if the germination problem could be addressed. The objective of this research is to determine why and how germination and emergence is affected in *pc*types compared to white- and colored-seeded types. A hypothesis is that seeds coats of *pc*types are more fragile and may crack more easily (either from mechanical damage and/or imbibitional injury), thereby leaking solutes into the rhizosphere that attract pathogens that parasitize the germinating seed. In laboratory germination tests, no difference was observed among *pc*, white- and colored-seeded cultivars, and germination levels were generally high. We repeated field tests and observed that *pc*types had a significantly lower ratio of untreated:treated seeds germinating compared to colored and white seeded types. Infected *pc*seeds were colonized by *Fusarium oxysporum*and more rarely, *Waitea circinata*. We also examined the anatomical structure of seed coat of genotypes with green (*pp pcpc*), white (*pp PcPc*) and colored (*$p^{gri}p^{gri}$PcPc*) seed. The outer testa layers were significantly thicker in 'OR 91G' (white) and GRI 2-1 (colored) than 'Pascal' (green) seeded types. These findings support the idea that *pc*seeds are more fragile and more likely to leak solutes into the rhizosphere. Breeding for reduced seed fragility in a *pc*background may be possible. These experiments can be supported with studies on solute leakage and susceptibility to mechanical and imbibitional damage.

Specified Source(s) of Funding: Turkish government

An asterisk (*) in front of a name indicates the presenting author.

Mapping QTL Associated with Anthracnose Resistance in Tomato *(Poster Board #267)*

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Anthracnose caused by *Colletotrichum* species is a serious disease of Solanaceous crops grown in North America. It is endemic in production regions of the Eastern and Midwestern United States and south-central Canada. We have selected an unadapted small-fruited tomato line, designated 95L368, that exhibits a high level of resistance to a broad range of *Colletotrichum* species that cause anthracnose on ripe tomato fruit. Resistance in 95L368 was primarily additive with two to three genetic factors estimated to be segregating for resistance. Utilizing a recombinant inbred line population that we developed from a cross of 95L368 and a susceptible tomato line, genotype by sequencing (GBS) was used to identify and map genomic regions associated with anthracnose lesion development. Using GBS, 15300 polymorphic SNPs were identified of which 1692 SNPs were mapped, spanning a length of 2519cM. A genetic map was constructed with a marker density of 1.48 SNP per cM. Lesion development in fruit for individual RILs was scored over two years. Our analysis resolved only three common QTLs (chromosomes 3, 6, and 9) that showed significant effects for both years. For chromosomes 6, we located six QTL peaks at the genomic region (9.6 Mb) located between 41717475 and 51338695. Percent of variance explained by these peaks ranged from 4.2 to 5.7% (LOD 3.21 to 4.34) for the first year and 5.7 to 22% (LOD 13.01 to 14.38) for the second year. On chromosome 9, we located QTL peaks in a region with genome size of 14Mb located between the position 53457523 and 67973214. Percent of variance explained by these regions varied from 4.1 to 6.2% in the first year and 5.5 to 11.2% for the second year. QTLs in other chromosomes (2, 8, 10) manifested strong QTL × year interaction, showing significant effects in the first year and no effect in the second year. Research is ongoing to identify candidate genes in these regions that are associated with lesion development.

Altering the Tomato (*Solanum lycopersicum* L.) Cholesterol Synthesis Pathway to Produce Vitamin D3 *(Poster Board #268)*

Vincenzo Averello IV*; Ryan Murphy and Changbin Chen, University of Minnesota

Vitamin D3 is important for maintaining bone health and preventing osteoporosis, with possible connections to diabetes, cardiovascular disease, and colon, breast, and prostate cancers. It was recently found that 39.92% of the population is Vitamin D deficient, particularly as age increases. Unlike most major vitamins Vitamin D3 is found in very few plants. However, a precursor of Vitamin D3, 7-dehydrocholesterol (7-Dhc), occurs in tomato (*Solanum lycopersicum* L.). Under normal conditions 7-Dhc is converted to cholesterol by the 7-dehydrocholesterol reductase-2 (Solyc06g074090.2). We hypothesize that if this gene is inactive, it will cause an increase in 7-Dhc, which will be converted by UV-B to previtamin D3, an isomer of vitamin D3.

The endogenous allele of 7-DR-2 was cloned and sequenced for the purposes of designing the guide RNA. Of the 8160 bp in the cloned fragment, all 5695 sequenced bases match the reference genome. A CRISPR-Cas9 plasmid has been developing, targeting six sites in six different exons. These were selected using CrisprP 2.0. The components of the plasmid include pMOD_A0103 which carries *AtCas9* driven by the Cestrum yellow leaf curling virus (CmYLCV) promoter, pMOD_B2103 which carries the sgRNA with Csy4 spacers, and the pMOD_C000 which carries no extra components but is required for the assembly. These were assembled into the transformation backbone pTRANS_201.

The CRISPR construct will be transformed into the new variety MTX-851 that has been developed at the University of Minnesota for short season and dwarf growth habit with good flavor. We have determined that this variety can be transformed and regenerated from tissue callus, presenting an opportunity to use this variety for gene editing and crop improvement.

Specified Source(s) of Funding: Minnesota Department of Agriculture

Phenotypic and Genetic Diversity of Texas A&M AgriLife Tomato Breeding Lines *(Poster Board #269)*

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Tomato (*Solanum lycopersicum*) production is constantly challenged by biotic and abiotic stresses that reduce yield and quality. The Texas A&M AgriLife Research tomato breeding program is developing conventional and specialty tomato cultivars for heat tolerance, fruit quality, and disease resistance. Field trials indicate that developed materials have high yield potential showing great stability across Texas regions. Furthermore, consumer flavor evaluation results showed preference for Texas A&M fruit compared to commercial checks. Up to now, the selection of elite lines in the breeding program has been done using conventional breeding approaches, in which large populations need to be screened for several breeding cycles. Although this approach has resulted in the release of high quality-high yielding cultivars, it is very time-consuming, delaying cultivar release. An alternative approach to improve breeding efficiency involves the use of modern molecular breeding techniques for population management including methods to obtain desired genetic heterogeneity in the end product cultivars. As an initial step into molecular breeding, a representative sample of 322 lines was characterized for yield and fruit quality parameters. Population was also sequenced using AgSeq approach. In total 10,326 variants were obtained using GATK. Genotypic data was used to calculate both genetic diversity partition and locus informativeness for ancestry assignment. Such genetic information's corresponding with the phenotypic data will open the opportunity for selection of parents with desired genetic combinations using molecular approaches to expedite cultivar development.

Assessment of the Variation in Reduction in Above-Ground Traits in a Set of Genetically Diverse Cowpea Genotypes Under Salt Stress *(Poster Board #270)*

Waltram Second Ravelombola* and Ainong Shi, University of Arkansas

Crop losses due to salinity can cost 12 billion US dollars per year globally. Salinity has been reported to have negative impacts on cowpea [*Vigna unguiculata* (L.) Walp] production. These impacts are acute when salt stress occurred at seedling stage. Due to improper agriculture practices such poor irrigation quality and fertilization misapplication, cropland areas affected by salinity have kept increasing. Salinity has been shown to limit the use of cowpea as a cover crop in the western part of the U.S. Breeding for cowpea salt-tolerant cultivars would be an affordable solution to alleviate the impacts of salinity on cowpea production. Therefore, the objective of this study was to evaluate the variation in quantitative above-ground traits in cowpea genotypes under salt stress at seedling stage and to identify promising salt-tolerant cowpea genotypes. A set of 331 genetically diverse cowpea accessions were phenotyped in a greenhouse for salt tolerance using a Randomized Complete Block Design (RCBD) with 3 blocks and 2 replications within each block. Plant height, stem diameter, fresh leaf biomass, and total fresh biomass were recorded before applying the salt stress and when the susceptible control (PI255774) was completely dead. Salt tolerance index ((Non-stress – Stress)/(Non-stress)) X 100) and indicator of salt stress ((After Stress/ Before Stress) x 100) were computed for each trait. ANOVA will be conducted using SAS v. 9.4 and mean separation will be achieved using a protected LSD procedure at α=0.05. Broad-sense heritability (*H*) will be computed for each trait. Our preliminary results showed a large variation in the aforementioned traits. The findings can contribute towards bettering breeding for salt-tolerant cowpea cultivars.

Evaluating Drought Tolerance in Pepper (*Capsicum annuum* L.) from the U.S. and Mexico *(Poster Board #271)*

Jack McCoy*; Leah McHale and Kristin Mercer, The Ohio State University

Global temperatures are increasing due to climate change, causing variations in precipitation and an accelerated risk of drought. This has major impacts on agricultural production and food security worldwide. One possible solution to mitigating the effects of climate change is genetic crop improvement, specifically through improved tolerance to abiotic stresses. Crop centers of domestication and diversity are an important source of genetic variation, which can be utilized in plant breeding. Wild, semi-domesticated, and landrace varieties may have local adaptations to specific environments that allow them to outperform non-local genotypes under the same conditions. Mexico is the center of domestication for chile pepper (*Capsicum annuum* L.). Chile pepper is found in a broad climatic range, in varying elevation, soils, and precipitation. Previously, an environmental association analysis was conducted on Mexican landraces and wild accessions in order to identify regions of the genome that contribute to drought tolerance. Twelve priority loci were identified as associated with drought-prone environments. The objective of this study was to sequence haplotype blocks containing the priority loci and expand into U.S. germplasm. A greenhouse drought experiment was conducted on 25 genotypes including 18 U.S. cultivars and seven previously evaluated Mexican accessions. Seedlings were transplanted into 6-liter pots after seven weeks and drought was applied one week later. Two treatments were applied: a daily watering (control) and weekly watering (drought). Yield (fruit count and weight), flowering date, branching, and above-ground biomass data were collected. Gas exchange and chlorophyll fluorescence were also measured using the LI-6800. Results indicate differences in plant performance under drought stress and sequence variation in priority haplotype blocks. Results could provide valuable insight into physiological and agronomic performance of pepper under drought stress and may be useful for continued breeding efforts.

How to Make Peppers Tolerant to Fruit Post-Harvest Water Loss? *(Poster Board #272)*

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Genus *Capsicum* belongs to the Solanaceae family and consists of at least 31 described species. Pepper fruit traits varies among marked cultivars, which may affect the rate of water loss during storage. The study objective was to elucidate the genic effects involved on post-harvest water loss in fruits of peppers landraces to provide tools for breeding programs on improve fruit quality. Eight landraces of *C. baccatum* were crossed in a complete diallel, and the F_1 seeds of 28 hybrids and eight parents were sown in three replicates following a randomized complete block design. An analysis of variance with mean tests, diallel analyses, one-way multivariate analysis of variance, and phenotypic and genotypic correlation matrices were performed to compare fruit water loss, width, length, total soluble solids, dry matter content and pericarp thickness at harvest and storage period. Variability among traits were higher for exocarp thickness and fruit length (six groups), followed by fruit width (five groups), total soluble solids and fruit wall thickness (four groups), dry matter content (three groups), and water loss and cuticle thickness (two groups). Water loss varied from 14% to 68%. Dry matter content increased as water loss increased, while fruit width and wall thickness reduced as dry matter content increased. Total soluble solids had a positive path coefficient value, indicating it is a key factor affecting water loss, while cuticle thickness and fruit width presented a negative direct effect value. Low water loss varieties can be developed from the landraces germplasm bank studied. Multiparent population developed in this study represent a unique material to breeding programs with the goal of extending shelf life of *Capsicum* fruits.

Water Utilization & Management (Poster)

Tree to Grass Water Use Ratios; Assessing Turfgrass' High Water Use in the Urban Landscape

(Poster Board #138)

Tamara J Wynne* and Dale A. Devitt, University of Nevada Las Vegas

Water demand in the southwestern United States continues to rise. The population of the Las Vegas Valley doubled from 2000-2010 and is now home to more than two million people. The residential sector uses 60% of all water consumed in the valley. Outdoor urban landscape irrigation is responsible for 70% of all residential use. These landscapes are dominated by trees and turf grass. Although the water use of turf grass species is well studied, little is known about the water use of landscape trees. To obtain a more complete picture of the tradeoffs between grasses and trees in urban landscapes in Southern Nevada, we conducted a tree to grass water use ratio study focusing on 10 common landscape trees and four turf grass species grown in the valley. We estimated water use by closing hydrologic balances (Evapotranspiration=water input-drainage-change in soil water storage) on mature trees planted in the ground and turf grass grown in lysimeters. We estimated transpiration of trees using Granier probes and estimated conductive tissue with a novel dye injection system. Sapflow was lower than the hydrological balance estimated evapotranspiration (ET) because of significant evaporation rates associated with irrigating trees in a desert environment. The values for sapflow ranged from 10 to 50 cm per year. Trees used less water than grass in nine out of 10 cases with an ET 38-88 cm/year determined by a hydrological balance. The exception was *Lagerstroemia indica* that used 196 cm $year^{-1}$ which was similar to the grass ET (106-262 cm $year^{-1}$) again determined by hydrological balance. We also developed models that predicted the tree water use based on reference evapotranspiration (ET_{ref}) and morphological characteristics such as tree height, canopy volume, basal canopy area, leaf area index (LAI) and leaf area. Replacing turf grass and planting trees can save water, if the right species are selected. However, turf grass serves it's purpose in many areas by providing aesthetics and recreational use. Water use values are listed to help assist in making landscape tradeoffs.

Specified Source(s) of Funding: USGA and USGS

Development of a Smartirrigation App for Peach Production in Georgia *(Poster Board #139)*

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Agriculture comprises 70% of the total fresh water use in the world. Irrigation management is very important due to limited water resources available and the competition for those resources for human and industrial uses. Proper irrigation scheduling is based on the crop water requirement at various developmental stages, optimizing crop water use and possibly increasing yield. Georgia is known for peach production but irrigation management guidelines specific to this region are limited to none. In general, peach trees are not irrigated until they start bearing fruits in their third or fourth year after planting. Irrigating young peach trees since establishment has shown to have a positive effect in vegetative growth and yield. However, specific irrigation recommendations are yet to be developed. SmartIrrigation apps have been created for many crops like citrus, avocado, cotton, and vegetables. They are used to schedule a crop's irrigation based on either their evapotranspiration or soil water balance method using real-time weather data. These apps are getting popular because of their efficiency and ease to use. Our objective was to develop a simple, handy, and free to use smart-phone irrigation app for peaches based on crop evapotranspiration (ET_c). ET_c estimation is a product of reference evapotranspiration (ET_o) and crop coefficient (K_c). ET_o was calculated using the FAO Penman-Monteith equation. K_c values for peaches at various growth stages were compiled by comparing literature published for peaches around the world. A demo app for peach has been developed. This app estimates crop water loss and provides an efficient real-time irrigation schedule. It requires basic information about the field area, crop age, soil type, and irrigation system (type, rate, and efficiency) used. Considering the data provided by the user, the system customizes and generates specific irrigation scheduling (irrigation amount and duration). For any expressive changes observed due to weather conditions, irrigation recommendations are promptly sent to the user via push notifications. Besides notifications, the user can also access a full schedule report that includes accumulated precipitation, irrigation amount, duration, and events. As a result, the app allows growers to have a better understanding of the irrigation requirements of their peach orchards by simply accessing their smartphone.

Keywords: Horticulture, Smart-phone app, Fruit crops

Specified Source(s) of Funding: USDA/AMS Specialty Crop Block Grant Project FP00013868

Opportunities to Improve Landscape Irrigation

(Poster Board #140)

Ursula K Schuch* and Jeffrey Gilbert, University of Arizona

Landscape irrigation is important to maintain healthy and aesthetic plants in arid regions. Many urban landscapes are irrigated via automated systems programmed to customize application of the amount and frequency of water application. We conducted a survey in Arizona to determine current practices commercial landscapers use in managing and maintaining drip irrigation systems in landscapes and how to improve irrigation efficiency. Questions asked where the respondent was employed, the number and type of properties they maintained, and their responsibility related to drip irrigation. The survey asked questions about how irrigation schedules are developed, when they are changed, about the system hardware, and common system maintenance practices. We used 151 responses in the analysis. All respondents worked in commercial landscape businesses or municipal entities. Respondents maintained various types of properties including single-family residences, sports fields, roadsides, and golf courses. Almost 90% of respondents maintained sites with drip or micro-irrigation to water trees, shrubs and annuals. Respondents developed drip irrigation schedules based on experience and personal preferences, irrigation systems performance data, supervisor preference, or smart controllers. Infrastructure age and maintenance, and scheduling of irrigation systems can improve irrigation efficiency. Drip irrigation schedules were changed three to five times a year by 41% of respondents. Few respondents used controllers with soil moisture sensors. Landscapers know how to improve drip irrigation systems but often lack the funds and time to implement necessary changes. This survey and other inquiries found that landscapers did not have access to a user-friendly tool to schedule landscape drip irrigation. The University of Arizona Landscape Drip Irrigation Scheduler was developed to assist in making a schedule for drip irrigated landscapes (https://cals.arizona.edu/dripirrigation/home) to maintain healthy plants while saving water. The app uses historic evapotranspiration data and is accessible for zip codes in California, Arizona, and the greater Las Vegas area. Required input includes soil type, plant type (tree, shrub, cacti/succulent, ornamental grass, flower, or groundcover/vine), a relative water requirement for plants, and the number of emitters and their flow rate per plant. The resulting schedule for each irrigation zone shows the runtime and the dates each month when the zone needs to be irrigated. The schedule also displays the yearly total water use per zone and the yearly total water use of all zones. Comparing actual irrigation amounts of large commercial landscapes to the amounts recommended by the landscape drip app demonstrated significant opportunities for saving water by using the drip app.

Specified Source(s) of Funding: Metropolitan Water District of Southern California, Bureau of Reclamation, Southern Nevada Water Authority, and Central Arizona Project

Assessing Tipping Bucket-Based Irrigation and Leachate Sensor Performance *(Poster Board #141)*

Quinn Cypher; Wesley Wright; Amy Fulcher; Lauren Fessler*; Jeff McHugh and Sun Xiaocun, University of Tennessee

Woody nursery crops are typically grown in bark-based substrates with low water holding capacities. Coarse substrates and static irrigation scheduling can waste water and leach pesticides and nutrients. Leaching fraction-based irrigation scheduling has the potential to conserve water and align irrigation with crop and environmental demand. The leaching fraction from a single irrigation event can be calculated from manually collected volume or gravimetric measurements. The objective of this research was to develop a reliable sensor for measuring irrigation or leachate volume that could be used as part of a system that would automatically calculate leaching fraction, determine irrigation operation time, and actuate irrigation accordingly. Sensors were composed of a tipping bucket assembly within a 6-inch (15.2-cm) diameter PVC pipe topped with a funnel to channel effluent from the container. A container-grown plant was placed on the funnel with a shield to prevent rain and overhead irrigation from entering the assembly. Leachate sensors were built and deployed, with twenty sensors at each of two nurseries in 2015. Sensors were calibrated to 0.28 fl oz (4.73 ml) per tip in spring 2017 at both nurseries and spring of 2018 at one. Post-calibration volume measurements recorded at the beginning of the season were compared with end of season volume measurements taken 4 to 6 months later with the same gauges. Volume was measured after applying 100 ml of water at a predetermined flow rate. Data were analyzed using a random block design with repeated measures with nursery as the block effect and season (spring or fall) as the repeated factor. Data were rank transformed prior to analysis due to non-normality and unequal variance. Multiple comparisons were performed with Tukey's adjustment. Equivalency tests, conducted with two one-sided tests (TOST), were performed using a 3% (3-ml), 5% (5-ml), and 10% (10-ml) threshold to assess if there was a practical difference in means. There was no effect of season; end of season measurements did not differ from spring post-calibration measurements (P-value = 0.4050). Means were not equivalent at 3% (P-value = 0.6785) or 5% (P-value = 0.3170) but were equivalent at 10% (P-value = 0.0029). An affordable sensor was developed for measuring irrigation or leachate volume in real-time nursery conditions. Additional studies assessing a system that integrates these sensors with a data logger to calculate leaching fraction from irrigation and leachate volume and actuate irrigation run time based on a target leaching fraction are ongoing.

An asterisk (*) in front of a name indicates the presenting author.

Specified Source(s) of Funding: NIFA

Comparing the Salt Tolerance of Three Landscape Plants Using Near Continuous Gradient Dosing System *(Poster Board #142)*

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Screening salinity tolerant plants is usually time intensive and only applicable to a limited number of salinity levels. The near-continuous gradient dosing system (NCGDS) developed by Hawk et al. (2009) allows researchers to evaluate a large number of plants for salinity tolerance with multiple treatments, more flexibility, and reduced efforts. *Hibiscus syriacus* (rose of sharon), *Physocarpus opulifolius* (common ninebark), and *Spiraea japonica* (japanese spirea) were irrigated daily using NCGDS with eight electrical conductivity (EC) levels ranging from 0.88 $dS \cdot m^{-1}$ to 6.46 $dS \cdot m^{-1}$. At 11 weeks after irrigation initiated, *P. opulifolius* and *S. japonica* had increased foliar damage along with increasing EC levels. The shoot dry weight of both species decreased linearly as EC levels increased. In addition, the stem diameter, growth index, number of inflorescences, relative chlorophyll content, and net photosynthesis rate of *P. opulifolius* and *S. japonica* decreased linearly or quadratically along with increasing EC levels. There was no significant difference among treatments in term of visual score, growth index, stem diameter, or dry weight of *H. syriacus*. However, the relative chlorophyll content and net photosynthesis rate of *H. syriacus* decreased linearly as EC levels increased. The salinity threshold of *P. opulifolius* and *S. japonica* was 5.42 $dS \cdot m^{-1}$ and 4.6 $dS \cdot m^{-1}$, respectively, but not determined for *H. syriacus*.

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Salt Tolerance of Sego Supreme™ Plants *(Poster Board #143)*

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Sego Supreme™ is a designated plant introduction program at USU Botanical Center and USU Center for Water Efficient Landscaping. This plant selection program is to introduce native and adaptable plants into the arid west landscapes for aesthetic landscape and water conservation. The plants are evaluated for disease resistance, drought tolerance, and invasiveness. However, salt tolerance is not one of the factors considered during the evaluation process. Salt tolerance of four Sego Supreme™ plants (*Aquilegia barnebyi, Clematis fruticosa, Epilobium septentrionale,* and *Tetraneuris acaulis* var. arizonica) was evaluated in a greenhouse experiment. Uniform plants were irrigated weekly with a nutrient solution at an electrical conductivity (EC) of 1.25 $dS \cdot m^{-1}$ as control or a salt solution at an EC of 2.5 $dS \cdot m^{-1}$ (EC 2.5), 5.0 $dS \cdot m^{-1}$ (EC 5), 7.5 $dS \cdot m^{-1}$ (EC 7.5), or 10 $dS \cdot m^{-1}$ (EC 10) for 8 weeks. At harvest (8 weeks after irrigation initiated), *A. barnebyi* in EC 5 had slight foliar salt damage with an average visual score of 3.7 (0 = dead; 5 = excellent), however, in EC 7.5 and EC 10, more than 50% of the plants were dead. However, *C. fruticosa, E. septentrionale.* and *T. acaulis* had minimal or no foliar salt damage with averaged visual scores of 4.2, 4.1, and 4.3 in EC 10, respectively. As the salinity levels of irrigation water increased, plant height, leaf area, and shoot dry weight of *C. fruticosa* and *T. acaulis* decreased linearly; plant height of *A. barnebyi* and *E. septentrionale* also declined linearly, but their leaf area and shoot dry weight decreased quadratically. Compared to the control, the shoot dry weight of *A. barnebyi*, *C. fruticosa*, *E. septentrionale*, and *T. acaulis* in EC 10 decreased by 71%, 56%, 70%, and 48%, respectively. *A. barnebyi* and *C. fruticosa* did not bloom during the entire experiment. Elevated salinity reduced the number of flowers in *E. septentrionale* and *T. acaulis*. In summary, *C. fruticosa* and *T. acaulis* were more tolerant to salinity, followed by *E. septentrionale*, and *A. barnebyi* had the least salt tolerance.

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Effect of Automated Soil Moisture Based Irrigation on Yield of Three Cultivars of Taro (*Colocasia esculenta*) *(Poster Board #144)*

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Taro has historically been grown under flooded paddy conditions, however production has moved towards irrigated upland production. Under upland growing conditions taro has shown to respond positively to increased irrigation. To better understand the relationship of irrigation on components of plant growth, three taro cultivars (‘Bun long’, ‘Lehua’ and ‘Pi‘i‘ali‘I’) were irrigated based on reference evapotranspiration (ET_0) and soil moisture. Irrigation treatments consisted of 100%, and 200% ET_0 replaced calculated using a modified Hargreaves Model and 100% and 200% of field capacity (FC) maintained by an Irrometer tensiometer sensor attached to an automatic irrigation timer. Irrigation rates significantly affected all growth characteristics, with the greatest differences between plants receiving 100-200% ET_0 replaced and plants maintaining 100-200% FC. On aver-

age, plants maintaining 100% and 200% of FC were heavier, taller and produced more cormels than plants receiving 100% and 200% ET_0 replaced, across all three cultivars. Plants maintaining 200% FC received the largest quantity of water and showed significantly greater yields than all other treatments. Plants receiving 200% ET_0 replaced received the second highest quantity of water, however produced significantly lower yields than plants receiving less water at 100% FC maintained. In addition, the potential to estimate corm weight based on its relationship to percent ET_0 replaced and percent field capacity maintained can assist in crop modeling and irrigation scheduling to maximize water use efficiency of taro. These models can also help to estimate cost benefit analysis, which can be used to determine the quantity of water needed to maximize yield and profits.

Effect of Deficit Irrigation and Planting Density on Physiology, Yield and Water Use of Cucumber in Semi-Arid West-Texas. *(Poster Board #145)*

Ved Parkash; Sukhbir Singh*; Rupinder Saini; Bishwoyog Bhattarai and Atinderpal Singh, Texas Tech University

Water scarcity is becoming a major concern for food production especially in the arid and semi-arid regions like Texas High Plains, where average annual evapotranspiration is much higher than the average annual precipitation. In this situation, irrigation management strategies that can conserve water are needed for sustainable food production. Deficit irrigation is one of the strategies that have the potential to improve water use efficiency in water scarce areas. A field trial was conducted during summer 2018 at Quaker Research Farm of Texas Tech University to evaluate the effects of the deficit of irrigation and seeding rate on physiology, yield and water use of cucumber. The experiment was laid out in a split-plot design with four irrigation levels [100% ET_c (crop evapotranspiration), 80% ET_c, 60% ET_c, and 40% ET_c] as main plot factor and two seeding rates [SR1 (0.3 m plant to plant distance) and SR2 (0.6 m plant to plant distance)] as the subplot factor with four replications. The yield was maximum in 100% ET_c irrigation treatment, but it was not significantly different from 80% ET_c irrigation treatment. A significant reduction in yield was observed for 60% ET_c and 40% ET_c irrigation treatments and it was 20.47% and 47.69% lesser compared to 100% ET_c, respectively. The irrigation water use efficiency was higher in 80% ET_c followed by 60% ET_c, 100% ET_c, and 40% ET_c. Stomatal conductance and leaf area index did not differ significantly among irrigation treatments. The effects of seeding rate on yield and physiological parameters were also not significant. Results indicate that 80% ET_c irrigation amounts could be used for successful cucumber production without a significant reduction in yield; however, more research is needed to support these findings.

Adaptability, Efficiency, and Impact of Irrigation Systems & Scheduling Methods on Small and Limited Resource Vegetable & Fruit Farms in MS *(Poster Board #146)*

Deon Rashard Holmes Sr.*, Alcorn State University

A Preliminary Analysis: Adaptability, Efficiency, And Impact of Irrigation Systems & Scheduling
Methods On Small and Limited Resource Vegetable & Fruit Farms in MS

Efficient use of water by irrigation is becoming increasingly vital. Methods such as drip irrigation may contribute significantly to best management practices for yield and water use in agriculture. Thus, helping limited resource farmers sustain economic stability. This preliminary study examines the effects of scheduled irrigation regimes designed for growing Aristotle X3R Hybrid bell peppers (Capsicum annuum) sprayed through a micro-irrigation system (drip irrigation) within a high tunnel (HT). To prepare the HT, firm seedbeds were generated before planting by wetting the soil and allowing a flush of weed seedlings. Five raised seedbeds were covered using a plastic mulch system integrated with drip tape to increase vegetable yields and reduce chemical (organic) input on weed control. Aristotle bell pepper seedlings (10) were transplanted into five rows of distinct plots, with sensors located between the 5th and 6th bell pepper plant. Irrigation regimes consisted of three irrigation intervals (15, 30, and 45 centibars). Sensor-based treatments (Granular Matrix Sensors) used soil moisture sensors buried at 8, 12, and 16 inches deep within the bell pepper root zone to maintain soil moisture at a set level. 900M Watermark Monitors adopting eight channel data loggers were also installed in the HT to continuously record data for analysis of trends and provide users with an active means of collecting information.

Objectives:

To determine optimal irrigation methods based on soil moisture sensors in a field and high tunnel setting.

To educate growers and improve the productivity and economic viability of small and limited resource growers and the communities they serve.

Materials:

Drip irrigation tape, plastic mulch, high tunnel, 900 M Irrometer watermark monitors, Granular matrix sensors, Rain Bird Electronic Garden Hose Watering Timer, Chapin Hydro Feed fertilizer injector

Effects of major treatment:

30 and 45 centibars(cb) treatments produced plants that had a higher index than the treatment at 15cb.

Major conclusion:

This experiment utilized sensors at two or more depths in the root system to determine how much water to was required to apply. To further improve uptake and soil tension, this ex-

An asterisk (*) in front of a name indicates the presenting author.

periment will be conducted both in an open field production system and the high tunnel. This addition will provide baseline information for small farmers and compare the economic potential of growing. Furthermore, steam sterilization will be implemented to reduce weeds, bacteria, and pests that may harm hybrid bell peppers. Coupled with steam sterilization and irrigation system, we will also utilize above-ground portable heaters powered by propane as supplemental heating to reduce plant mortality from inclement weather.

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Weed Control & Pest Management 1 (Poster)

Bringing Pest Control to You: Using Native Flowering Species to Attract Beneficial Insects *(Poster Board #084)*

Kevin J. Burls*, University of Nevada and Heidi A Kratsch, University of Nevada Cooperative Extension

Native flowering forbs and shrubs are primary nectar sources for a large diversity of native insects. These insects have multiple ecological functions, including not only pollination, but also control of many plant herbivore populations through predation and parasitism. Protection and support of native insects for control of agricultural and horticultural pests is one strategy in Conservation Biological Control and is an important integrated pest management technique. Native plantings also provide crucial foraging resources for native pollinator species. The goal of this project is to create demonstration native plant gardens throughout Nevada at both the residential scale and in agricultural settings that will attract native insect pollinators, predators, and parasitoids. The gardens can be used to evaluate the survival and growth of native plant species on an ongoing basis, and to assess their attractiveness to native pollinators and other beneficial insects. Three residential-scale plots were established the fall of 2018 in Reno, Las Vegas, and Overton, Nevada, with 9-month old seedling transplants of fourteen shrub species and two perennial bunchgrasses. A one-third-acre agricultural plot was established in fall of 2018 in Yerington, Nevada, using seeds of 11 forb species and one perennial bunchgrass. Species for both types of sites were selected based on their seed or seedling availability and geographic range, along with a range of pollinator-related characteristics including flower color, flower shape and size, and bloom period. Residential plots were evaluated and plant mortality compensated with replacements in early March 2019. Survival rates of seedlings at the residential plots were between 85% and 90%, and mortality was not concentrated on any particular plant species or family. There were substantial differences in initial plant growth among species in the two southern Nevada locations, with species in bloom or budding in Las Vegas that were still only in rosette or early leaf-out stage in Overton. Plants with the quickest blooms included *Baileya radiata, Oenothera caespitosa*, and *Sphaeralcea ambigua*. Residential sites varied in many environmental characteristics, including aspect, elevation, exposure, and soil type, so differences among sites were expected. Future work includes monitoring germination success and early growth at the Yerington location, recording local bloom periods, and monitoring flowers for insect visitation.

Specified Source(s) of Funding: United States Department of Agriculture

Field Evaluation of Mustard and Sunflower Seed Meal for Weed Management in Pumpkin *(Poster Board #085)*

Rupinder Saini*; Azeez Shaik; Atinderpal Singh and Sukhbir Singh, Texas Tech University

Weed control using agricultural by-products provides an attractive and promising alternative solution to chemical herbicides. Mustard seed meal (MSM) and sunflower seed meal (SSM) are byproducts of seed oil extraction process. They release biologically active allelochemicals that can provide a resource for supplemental nutrients and weed suppression in vegetable cropping systems. Field experiment was conducted at Texas Tech University, Lubbock, TX to determine the phytotoxic impact of MSM and SSM on weeds and seedling establishment of direct-seeded pumpkin. The experiment was conducted in randomized complete block design and two different rates of seed meals (1100 kg ha^{-1} and 2250 kg ha^{-1}) were incorporated into the soil one week before the planting of pumpkin. Plant toxicity and weed control ratings were collected during the experimental period. The results will be presented in the poster.

A Comparison of Currently Available Weed Management Tools for Certified Organic Northern Highbush Blueberries (*Vaccinium corymbosum*) in Oregon's Willamette Valley *(Poster Board #086)*

Erik N. Augerson* and Marcelo L. Moretti, Oregon State University

Northern Highbush Blueberries (*Vaccinium corymbosum*) are an economically important crop for Oregon and the Pacific Northwest. Many organic growers apply synthetic mulches in the planting row and hand-weed to manage weeds in fields. As the cost of hand-weeding increases, alternatives are required. The object of this study was to compare the efficacy of saturated-steam (SW-900), brush-weeding (ID-brush weeder), ammonium nonanoate (AXXE®), and capric+ caprylic acid (Suppress®) to an untreated control. The experimental design was a five by five factorial arranged in a complete block with four replicates. Treatments were followed by a second application 28 days later resulting in all possible combinations (25 treatments).

Sharp-point fluvellin (*Kikxia elatine*) and prostrate knotweed (*Polygonum aviculare*) were the most abundant weeds in the study. No significant interactions among sequential treatments were observed. At 28 DAT, total weed biomass was significantly reduced by saturated steam, brush weed, and ammonium nonanoate. A significant interaction among treatments was observed at the final evaluation. All treatments that included saturated-steam resulted in excellent total weed control (83-93%) regardless of the initial treatment. Performance of brush-weeder (58-89%), ammonium nonanoate (48-81%), and capric + caprylic acid (45-75%) were superior after a successful initial treatment, indicating that these treatments perform better against smaller weeds. Saturated-steam (88-95%) was the most consistently effective at controlling knotweed. Brush-weeding (65-94%), ammonium nonanoate (43-90%), and capric + caprylic acid (45-74%), although effective, were again dependent on the success of the initial treatment. Control of sharp-point fluvellin with saturated-steam (75-91%), brush-weeding (43-81%), ammonium nonanoate, (40-80%) and capric+ caprylic acid(42-55%) were effective but to a lesser degree than for total weed and knotweed control. At $32 and $42 per application per treated acre, respectively, saturated-steam and the brush-weeder were the most cost-effective tools. Ammonium nonanoate and capric + caprylic acid, cost $270 and $187 per treated acre, respectively. Saturated steam and brush-weeder are cost-effective weed control alternatives. These are early data from a study that continues until 2020.

Specified Source(s) of Funding: USDA-NIFA Organic Transition Program, USDA Center for Small Fruit Research, Oregon State Agriculture Research Foundation

Thermal Death Models Simulating Response of California Weed Seeds to Soil Solarization *(Poster Board #087)*

Timothy Jacobs*; Ashraf Tubeileh; Adam Tassinari and Scott Steinmaus, California Polytechnic State University-San Luis Obispo

Soil solarization places thin (1-2mil), clear plastic over soil to generate lethal temperatures for weed seeds and soilborne organisms. Finding thermal death thresholds for important weed seeds in California agriculture can help growers more effectively use soil solarization in their fields. Lab experiments simulating soil solarization conditions tested weed seeds at five soil temperatures that occur during solarization in California (40°C, 45°C, 50°C, 55°C, and 60°C). Seeds tested included little mallow, redstem filaree, bristly oxtongue, annual sow thistle, common purslane, common lambsquarters, and redroot pigweed. Efficacy of solarization temperatures differed between different species. Cool season annuals annual sow thistle and bristly oxtongue were more susceptible to heat treatments than warm-season annuals redroot pigweed and common lambquarters. Common purslane and hard seeded weed species little mallow and redstem filaree were the least susceptible to heat treatments. Complete (100%) mortality was achieved at all temperatures tested for lambsquarters, sow thistle, and bristly oxtongue. Redroot pigweed was not affected by 40°C treatments. Common purslane, redstem filaree, and little mallow were not affected by 45°C and 40°C treatments. All seeds were tested at 3 or more different times at temperatures where heat treatments increased weed seed mortality. Time and percent mortality of weed seeds were used to create thermal death models for weed seeds.

Specified Source(s) of Funding: Organic Farming Research Foundation (OFRF), Harold G. Hull Assistantship

Integration of Steam with Allyl-Isothiocyanate and Mustard Seed Meal for Soil Disinfestation

(Poster Board #088)

Dong Sub Kim*[1]; Steven Kim[2]; John Rachuy[1] and Steven A. Fennimore[1], (1)University of California, Davis, (2)California State University, Monterey Bay

The sulfur containing compounds can be used as additives to improve the efficiency of steam application in agricultural fields. Our previous studies demonstrated that allyl-isothiocyanate (AITC) and mustard seed meal (MSM) suppressed growth and germination of weeds and plant pathogens. The objective of this study was to investigate the synergistic effect of steam and the sulfur containing compounds against weed seeds and a plant pathogen. This experiment was conducted on June 15 and October 24, 2018. Four weed seeds (knotweed, purslane, pigweed, and nettle) and a strawberry pathogen (*Verticillium dahliae*) were enclosed in nylon bags and introduced in microplots at 100 mm depth and 0.3, 0.5, and 0.7 m distant from the center. Dominus (99.8% AITC) was applied at the center of microplots (18.7 mL m^{-2}), and MSM was applied at (333 g m^{-2}). Steam was applied at a pressure of 5 bar for 60 min in the center of microplots. The maximum soil temperatures at 0.3, 0.5, and 0.7 m from the center of steam treatment were 99.6, 99.7, and 99.5°C and time of above 65°C was 191.5, 136.5, and 115.5 minutes, respectively, while the maximum soil temperatures were 20.3°C at 0.7 m and 30.8°C at 0.3 m in non-steamed microplots. The steam treatments such as steam only, steam + MSM, steam + Dominus, and steam + Dominus + MSM showed a significant decrease in the weed seed viability and germination of *V. dahliae* in all distances compared to control, but MSM only and Dominus only treatments didn't. The steam + Dominus treatment, especially, reduced the viability of pigweed and nettle seed at 0.7 m distance compared to steam only and Dominus only treatments. The results suggest that Dominus can complement the effect of steam application for soil disinfestation.

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Creating a Multivariate-Multifunctional Data-

base for Weed Control to Support Organic Mix Vegetable Production *(Poster Board #089)*

Yaqeen Salatneh Ashqer*; Chyi Lyi Liang and Marwan Bikdash, North Carolina A&T State University

The organic sector has become one of the fastest growing agricultural movements in the United States. Many communities have made remarkable progress in promoting and supporting organic farming. Weed management is one of the most significant challenges for organic vegetable growers since weed invasion reduces crop yield and quality. Many environmental and climate variations affect vegetable-weed competition corresponding to different field practices. Hand weeding has been the most popular practice for small-scale organic vegetable growers. Unfortunately, hand weeding forces farm workers to work in a stooped and uncomfortable position for long periods, which can lead to serious chronic health problems and essential direct and indirect costs to the farmers and workers.

The purpose of this presentation is to share an innovative method to design, develop, and implement a multivariate-multifunctional database to help small-scale organic farms to prevent weeds starting from the initial stage of production. We monitored different types of vegetables in Spring 2019 (Beet, Carrot, Kale, Swiss chard, Pepper, and several types of Tomato, Lettuce, and onion) produced on 0.5 acre plot in a small urban farm in Guilford County, North Carolina. We documented environmental and climate factors for all vegetables above: The plot soil characteristics, air temperature, soil temperature, humidity, and weather conditions (sunny, cloudy, rain showers, etc.) Growing condition records included labels of the seeds and soil for transplants in the tray, the total number of seeds in each cell, the type of horticultural vermiculite has been used, lighting and tray location/arrangement in the transplant stage, plant height from seeding stage to semi-mature stage, type of weeds appearing in different stages corresponding to vegetable growth, the time of putting the transplants in the ground, the way of putting the transplants in the ground. This database incorporates numbers of records, description of conditions, and photo images of vegetable and weed growth.

The expected contribution of this study is to find or calculate (1) the correlation between vegetable growth, weed growth, and circumstantial factors with respect to human decisions and climate variations; (2) the average and optimized vegetable growth rates corresponding to natural and human factors; and (3) the survival ratio between vegetables and weeds under a well-monitored environment.

Weed Suppressive Potential of Legume Cover Crops in the Valley of Les Cayes, Haiti *(Poster Board #090)*

Jean-Maude Louizias*[1]; Carlene A. Chase[1]; Ludger Jean-Simon[2]; Zane Grabau[1] and Wesly Jeune[3], (1)University of Florida, (2)American University of the Caribbean of Les Cayes, (3)Faculté des Sciences de l'Agriculture et de l'Environnement, Université Quisqueya, Port-au-Prince, Haiti

Haitian farmers are still very dependent on tillage and hand-weeding for managing weeds in vegetable crops even though tillage can cause soil erosion and long-term decline in soil productivity and soil fertility. Because of limited financial resources for purchase of herbicides and loss of laborers to urban migration, farmers can benefit from nonchemical weed management approaches. The use of cover crops was proposed as a means of suppressing weeds and nematodes during the off-season prior to vegetable crops. The objective of the study was to evaluate the efficacy of different legume cover crops for management of weeds and plant-pathogenic nematodes for eggplant production in Haiti. In summer 2018, three legume cover crops were evaluated in field trials at two locations (Ducis and Camp-Perrin) in the valley of Les Cayes, Haiti. The cover crops used were: velvet beans (*Mucuna pruriens*), cowpea (*unguiculata* cv. Iron Clay), and sunn hemp (*Crotalaria juncea* cv. Tropic Sun), with a fourth treatment being a no cover crop control. The trials were stablished in late June with seeding rates of 45, 78, 56 $kg \cdot ha^{-1}$, respectively. The experimental design was a split plot with main plots arranged in a randomized complete block with four replications. Cover crop treatments were assigned to the main plots and eggplant was grown in subplots with or without supplemental mineral fertilizer. During the cover cropping period data were collected on cover crop shoot biomass accumulation, weed density, and weed biomass; and soil was sampled and extracted for nematodes. Eggplant growth and yield were assessed during the cash crop period as well as persistence of weed and nematode suppression. In both locations, fresh shoot biomass was higher with sunn hemp than with cowpea and velvet bean. Sunn hemp and cowpea cover crops suppressed weeds more effectively than velvet bean at Camp Perrin whereas only sunn hemp resulted in significant weed suppression at Ducis. Our results indicated that the suppressive performance of cover crops on weeds depends on the amount of biomass produced by the cover crops. Poor velvet bean germination resulted in low cover crop biomass and thus inadequate weed suppression. Sunn hemp appears to have the best potential as a weed suppressive cover crop. However, increasing the cowpea seeding rate, and use of velvet bean with higher seed viability may improve the performance of these cover crops. Results on plant-parasitic nematodes and eggplant growth and yield will also be presented.

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Pre-Emergent Herbicides and Hand-Weeding for Perennial and Annual Weed Management in Ha-

waii Green Onion Field Systems *(Poster Board #091)*

Joshua Silva*; Jensen Uyeda; Koon-Hui Wang; Jari Sugano and Amjad Ahmad, University of Hawaii at Manoa

Perennial and annual broadleaf and grass weeds can greatly impact yield and labor costs of Hawaii green onion (*Allium fistulosum*) farms. Misuse of post-emergent herbicides can result in developed resistance by weed species as well as crop injury. Thus, local farmers expressed a need for pre-emergent herbicide recommendations. Three pre-emergent herbicides were evaluated against hand-weeding and an untreated control in a randomized complete block design. Herbicides included pendimethalin (Prowl H_2O, max rate=2 pints/acre), dimethyl tetrachloroterephthalate (Dacthal Flowable, max rate=14 pints/acre), and oxyfluorfen (GoalTender, max rate= 1 pint/acre). Green onion seedlings (Koba variety, 2 weeks old) were transplanted into prepared beds on September 13, 2017. Each treatment plot was replicated four times, separated by 1 ft between plots, and consisted of four rows, 14 seedlings per row, and 8 inch spacing between rows and seedlings. Pre-emergent herbicide treatments were applied immediately after transplanting at the maximum allowable rates. Hand-weeding of all weeds was conducted in specified plots 3 weeks after planting. Aboveground yield was measured and weed severity visually assessed within a 9 sq ft area for each plot at 6 weeks after planting. A five-point scale of severity consisted of 0=no weeds, 1=1-25% weed cover, 2=26-50%, 3=51-75%, and 4=76-100%. Weed species were also identified and tallied per plot. Data analyses included One-Way ANOVA with Tukey Comparison using Minitab 18.0. Oxyfluorfen was the superior pre-emergent weed control product. Oxyfluorfen provided the statistically greatest weed control (average weed score= 0.25; $P<0.0005$), followed by pendimethalin and hand-weeding (score= 2, 2.5). Untreated and dimethyl tetrachloroterephthalate (DPCA) treatments were completely overgrown with weeds at harvest (score= 4, 3.5). All four weed treatments produced greater yields than the untreated plots ($P<0.0005$), but oxyfluorfen (average yield= 1.43 lbs) exhibited significantly greater yields than DPCA and untreated plots (average yields= 0.98, 0.54 lbs). Effective treatments controlled weed species such as *Amaranthus viridis*, *Hypochaeris radicata*, *Lepidium didymum*, *Portulaca* spp., *Sida spinosa*, and *Panicum* spp. of grasses. Only oxyfluorfen was able to completely control *Pyllanthus niuri*, with pendimethalin and hand-weeding controlling to lesser extent. Oxyfluorfen and pendimethalin were also the most cost-effective treatments at $23 and $13 per acre, respectively, while DPCA and hand-weeding were ten- or hundred-times more expensive at $354 and $2823 per acre. Utilization and even rotation of oxyfluorfen and pendimenthalin pre-emergent herbicides can provide Hawaii green onion farmers with an effective and inexpensive means to control perennial and annual weeds.

Biobased Weed Management in Specialty Crops: Developing New Products and Application Technologies *(Poster Board #092)*

Sam E. Wortman*[1]; Frank Forcella[2]; Sharon Clay[3]; Daniel Humburg[3]; Allison Butterfield[4]; Eliott Gloeb[1]; Sibel Irmak[1] and Loren Isom[1], (1)University of Nebraska - Lincoln, (2) USDA-ARS Soils Lab, (3)South Dakota State University, (4)University of Nebraska

Biobased crop management inputs are renewable and promote landscape-scale carbon and nutrient recycling. At the farm-scale, biobased inputs can provide multiple agronomic functions, including weed control, and can be less toxic to humans and the environment than synthetic inputs. Corn and soybean production and industrial processing (e.g., biofuels) in the Midwest U.S. results in a number of byproducts, including corn gluten meal (CGM) and soybean meal (SM), that have potential value as biobased crop management inputs. Our objective is to develop new products from and application technologies for corn and soybean processing byproducts in specialty crops. Toward this objective, we have conducted many lab, greenhouse, and field tests over the last five years to: 1) develop an abrasive weeding applicator and application recommendations for granulated CGM and SM grits, 2) integrate weed and nitrogen management with banded applications of CGM and SM in the crop row, and 3) develop formulations of and application technology for sprayable mulch films for in-row weed control. CGM and SM applied as abrasive grits reduced in-row weed density up to 97%, depending on weed community composition, density, and growth stage, which led to a 10%-45% increase in crop yield relative to a weedy control. High rates of CGM and SM (1.2 – 4.4 kg/m^2) banded in the crop row after crop transplanting (but prior to weed emergence) consistently reduced weed emergence in tomato (*Solanum lycopersium* L.) and broccoli (*Brassica oleracea* L. var. italica), and increased mineral soil nitrogen, but was also toxic to tomato plants in one season and reduced yield. Sprayable film solutions containing water, glycerol, corn starch, corn gluten meal, and soy protein isolate reduced weed biomass by approximately 79% and 87% when applied before and after weed emergence, respectively (at rates between 5.1-10.2 L/m^2). Water is the primary ingredient in the sprayable solutions (63%-77%), but we aim to reduce water content and are developing a high-viscosity applicator that would enable reduced application volumes and cost on a field-scale. Collectively, results demonstrate the agronomic value of corn and soybean byproducts as inputs in specialty crop systems, but further research and development are needed prior to commercialization and on-farm adoption of the proposed technologies and tactics.

Volatile Fatty Acid Production during Anaerobic Soil Disinfestation and Its Effect on Suppression of *Rhizoctonia Solani* *(Poster Board #093)*

Utsala Shrestha*[1]; Keagan Swilling[1]; J. Hollis Rice[1]; Sujata Agarwal[1]; Bonnie H. Ownley[1] and David Butler[2], (1)Univer-

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Anaerobic soil disinfestation (ASD) is known to suppress multiple soilborne plant pathogens of horticultural crops. During ASD treatment, soil microbial activity is enhanced by labile carbon amendment to create anaerobic conditions resulting in production of volatile fatty acids (VFAs) and other antifungal volatiles. Our objectives were 1) to determine rates of VFA production during ASD with two soil amendment mixtures (wheat bran or dry molasses-based) at a range of C:N ratios (10:1, 20:1, 30:1 or 40:1), and 2) to evaluate survival of *R. solani* inoculum exposed to VFAs as a function of VFA, VFA concentration, and soil pH. For objective 1, a growth chamber pot study was conducted with sandy loam soil incubated with ASD amendments, soil samples collected during treatment and extracted with KCl, and VFA concentration quantified by HPLC. VFA production was highest at 20:1 and 30:1 C:N ratios for dry molasses amendment and 40:1 C:N ratio for wheat bran amendment. VFAs observed included acetic, propionic, *n*-butyric, isovaleric, valeric and isobutyric, and concentrations varied by amendment, soil type, amendment C:N ratio, and sampling time. For objective 2, we evaluated effects of VFA soil exposure on *R. solani* inoculum survival in an anaerobic chamber. VFAs of acetic, *n*-butyric, or valeric acids, a mixture of acetic and *n*-butyric acids at 4 or 8 mmol/kg soil were maintained at soil pH 4.5 or 5.5 in sandy or sandy loam soil for 5 days, and survival of *R. solani* enumerated by toothpick baiting technique. Controls (water or HCl) were included. Similarly, a pot study was conducted with 4 mmol/kg soil VFA concentration (acetic, propionic, *n*-butyric, isovaleric, valeric and isobutyric) at a soil pH of 5.0. ASD treatments (dry molasses or wheat bran-based amendments) and controls (HCl and unamended saturated/non-saturated) were also included, and suppression of *R. solani* and disease development on common bean evaluated. Suppression of *R. solani* inoculum was observed for all VFAs when compared to controls. There was a limited effect of VFA concentration and soil pH at the levels used in our study. In the pot study, lowest recovery of *R. solani* was observed from propionic, *n*-butyric, isovaleric and mixture of acetic and butyric acids (67-79% less than controls). ASD treatments reduced *R. solani* propagules by 31-53% compared to unamended controls. Bean emergence and root disease rating was lower in all treatments when compared to the non-saturated control, but was not different from the HCl or the saturated control.

Specified Source(s) of Funding: USDA-NIFA-SCRI & USDA-ARS

Which Landscape Mulch Is Most Compatible with Preemergence Herbicides? *(Poster Board #094)*

Debalina Saha[1]; Chris Marble[*2]; Brian Pearson[3]; Hector E. Perez[2]; Gregory E. MacDonald[2] and Dennis C. Odero[2], (1) University of Florida - Mid Florida Research and Education Center, (2)University of Florida, (3)University of Florida, Mid-Florida Research and Education Center

Mulch, preemergence herbicides, or a combination of these two materials may be used in landscape planting beds for weed management. Several types of mulch materials and crop residues have been shown to intercept and bind with preemergence herbicides and reduce control in cropping systems. This has led to some debate as to whether or not preemergence herbicides can or should be used in combination with common organic mulch materials, and which mulch material is most compatible with preemergence herbicides. Experiments were conducted in 2018 to assess herbicide movement through three mulch types including pinebark, pinestraw, and hardwood. Weed species evaluated were large crabgrass [*Digitaria sanguinalis* (L.) Scop.], garden spurge (*Euphorbia hirta* L.), and eclipta [*Eclipta prostrata* (L.) L.]. Liquid formulations of prodiamine, dimethenamid-P + pendimethalin, and indaziflam were applied to soils that were either mulched with the above listed materials at a depth of 5.1 cm or left non-mulched. After herbicide treatments were applied, 3.8 cm of irrigation was applied over 3 days and then all mulch was removed and weed seeds were sown to determine herbicide movement through each mulch type. Data collection included weed counts and biomass determination at 4 weeks after seeding. Control of each weed species in pots that were originally mulched was then compared to control of each weed species that contained no mulch at the time of application. Results from seeding studies showed only 67% eclipta control was observed in pots originally mulched with hardwood, while pinebark and pinestraw had no effect on efficacy. Large crabgrass data showed that pinebark (65% control) was the only mulch type that caused a significant reduction in prodiamine efficacy. Dimethenamid-P + pendimethalin efficacy on garden spurge was reduced in pots originally mulched with hardwood or pinebark, but all treatments provided ≥94% control. While differences were observed with all preemergence herbicides evaluated, pinestraw was the only mulch material that did not decrease the control of any herbicide. Based on the results of this study, pinestraw may be a more compatible mulch material for use in combination with preemergence herbicides.

Soil Steaming: A Potential Alternative to Disinfesting Soils in Mississippi *(Poster Board #095)*

Xin Ye[*1]; Jacqueline McComb[2]; Christine E. H. Coker[3] and Shaun Broderick[1], (1)Mississippi State University, (2) Alcorn State University, (3)Mississippi State University Coastal Research and Extension Center

Soil is the basis for growing crops, but is also home to weed seeds, pathogens, and insects. These can build up over time to a point that the land is no longer economically viable to farm. Many methods to reduce these soil-based problems have been developed, including fumigation and solarization. Soil fumigation requires the use of chemistries that are toxic and potentially dangerous to users. Additionally, users must be certified and trained to use these chemicals safely. Solarization requires several weeks or even months to be effective. At the turn of the century, steam was used to disinfest soil but fumigation was selected as the preferred method. With restrictions on fumigants and herbicides use under organic production, there is increasing interest in alternative soil-disinfesting methods. We tested soil steaming as a method of reducing weed populations in central Mississippi with a goal of understanding the parameters that impact the time required to reach killing temperatures and optimize its effect on the soil. Steamed sections of soil (500 sq ft for each section) took 1.5-2 hr to reach 180 °F at a depth of 4 in using a steam generator that produces up to 680 lb/hr. The weed population was reduced by more than 95% 5 months after steaming. This would provide enough time for crops to have canopy closure or cover crops to establish before weed seeds repopulated the area. Soils that were tilled after steaming to a depth of 4 to 6 inches developed the same weed density as plots that were not steamed. We also found that soil that is saturated with water or compact was extremely difficult to steam and never reached 180 °F, at a depth of 4 in, within 2 hours. In future work, we will also be evaluating soil steaming on *Sclerotium rolfsii*, the pathogen that causes Southern Blight on tomatoes and results in large economic loses to tomato farmers in Mississippi. This technology, in its current state, will likely be limited to small farms and high tunnel production. Additionally, a company startup could utilize this technology to improve community public gardens or private gardens of home owners. As improvements are made in steam delivery to the soil, it may be possible to ramp up the size of steaming capacity and the farming operations for which it could be utilized.

Specified Source(s) of Funding: USDA NIFA #2015-68006-2290 and USDA Hatch MIS-212060

Weed Control Assessment of Anaerobic Soil Disinfestation Treatments Using Brewer's Spent Grain and Distiller's Yeast in Strawberry Annual Hill Plasticulture Production *(Poster Board #096)*

Danyang Liu*[1]; Jayesh Samtani[1]; Jeffrey F. Derr[1]; David M. Butler[2] and Charles Johnson[3], (1)Virginia Tech, (2)The University of Tennessee, Knoxville, (3)Southern Piedmont AREC, Virginia Tech

Anaerobic soil disinfestation (ASD) has proven to be an effective alternative to chemical fumigation to control soilborne plant pathogens and several weed species. An objective of this study was to evaluate the weed control potential of ASD when brewer's spent grain was used as a carbon source. This study also estimated a new method that included distiller's yeast to be combined with brewer`s spent grain. Treatments in the study were brewer`s spent grain full rate (4mg C / g soil, 6 ton/acre) with/without distiller`s yeast, brewer`s spent grain half rate (2mg C/ g soil, 3 ton / acre) with/without distiller`s yeast, Pic-Clor 80 that was shank-fumigated at 325 kg/ha and an untreated control with/without distiller`s yeast. There were four replicates for each treatment, and each replicate was a bed of dimension 10.6 m long by 0.8 m wide. The center 4.6 m length of each bed was used for planting strawberry, and 1.5 m length adjacent to planting area was used for weed data collection by creating fixed quadrat. All beds were covered with a black colored virtually impermeable film at the time of treatment initiation except quadrat areas were replaced post-treatment completion with clear plastic film. The 3-week ASD was initiated on 5 September 2018 and ended on 26 September; the Pic-Clor 80 was applied on 7 September 2018. Following the preplant treatments, 'Ruby June' strawberry plugs were transplanted in two rows at a 36 cm in-row spacing, and 16 plants in each bed on October 7, 2018. Weed density count by species and biomass data were collected from fixed quadrat areas once per month from November 2018 to March 2019. Neither brewer's spent grain dosage rate, nor yeast, had an effect on the total weed density and biomass. However, weed density and biomass in ASD treatments and Pic-Clor 80 were significantly lower than the untreated control.

Specified Source(s) of Funding: Virginia Tech. College of Agriculture and Life Sciences

Undergraduate Student 2 (Poster)

Salt Tolerance of Five Spirea Species *(Poster Board #008)*

Julie Hershkowitz*[1]; Liqin Li[2]; Yuxiang Wang[3]; Youping Sun[1] and Xin Dai[4], (1)Department of Plants, Soils, and Climate, Utah State University, (2)Huzhou Central Hospital, Zhejiang University, (3)Xinjiang Agricultural University, (4) Utah Agricultural Experiment Station, Utah State University

Spirea (*Spiraea* sp.) plants are commonly used as landscape plants in the Intermountain area of the western United States including Utah. The salt tolerance of *Spiraea betulifolia*, *S. japonica*, *S. media*, *S. nipponica*, and *S. thunbergii* were evaluated in a greenhouse. Plants were watered with a fertilizer solution at an electrical conductivity (EC) of 1.2 $dS \cdot m^{-1}$ (control) or saline solutions at an EC of 3.0 or 6.0 $dS \cdot m^{-1}$ once a week for 8 weeks. Eight weeks after the start of treatment, all spirea plants survived when they were irrigated with a saline solution at an EC of 3.0 $dS \cdot m^{-1}$. At this treatment, all spirea species remained good or excellent visual quality with visual scores greater than 4 (0 = dead, 5 = excellent) with an exception of *S. thunbergii* that exhibited slight foliar salt damage with an average visual score of 3.8. When irrigated with a saline solution at an EC of 6.0 $dS \cdot m^{-1}$, *S. thunbergii* plants all died. *S. media* had severe foliar salt damage with an average visual score of 1.5, while *S. betulifolia*, *S. japonica*, and *S. nipponica* showed moderate foliar salt damage with visual scores around 3. On average, the shoot dry weight of all spirea species irrigated with saline

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solutions at EC of 3.0 and 6.0 dS·m^{-1} decreased by 19% and 48%, respectively. In conclusion, *S. japonica*, *S. nipponica*, and *S. betulifolia* were relatively more salt tolerant than *S. media* and *S. thunbergii*.

Specified Source(s) of Funding: USDA NIFA Hatch project UTA01381, New Faculty Start-Up Funds from the Office of Research and Graduate Studies, Utah Agricultural Experiment Station, and the Center for Water-Efficient Landscaping at Utah State University

How Soil Management Practices Impact Soil Characteristics:a Study Conducted in Western Kentucky *(Poster Board #009)*

River O. Dowell* and Iin Handayani, Murray State University

Understanding soil properties and their changes is an important key of sustainable agriculture. This study was conducted to observe the difference of soil properties regarding to common tillage systems in Kentucky. Undisturbed and disturbed soil samples were collected from Butler County, western KY at the depth of 0-7.5 cm and 7.5-15 cm from areas which have been tilled through traditional methods (plowed, disked, and rotary tilled). In addition, the same soil samples were taken from a no till hay field, woodland and pasture land for comparison. Soil compaction level as indicated by penetration resistances was determined *in situ*. The samples were analyzed for soil water retention, soil organic matter, the level of acidity, bulk density, and porosity. Soil carbon content was higher in traditional tillage systems at 6.7% than in no-till soils, which were at 3.4%. The data shows that soil porosity is higher in conventional tillage soils at 63% than other non-intensively tilled soils which were at 50%. Soil water content at field capacity under conventional tillage management systems was at 34%, while soils under other management systems were 57% average. Bulk density is lower in soils under traditional tillage systems at 0.98 g/cm^3 than soils under other practices which fell at 1.35g/cm^3. Undisturbed soils had consistently higher water holding capacities at 77% than conventional tillage soils which fell at 64% respectively. Soil pH in woodland and agricultural fields was 6.9 and 7.3, respectively. No acidity was found in all fields. Soil compaction was shown more in no-till soils than conventional tillage systems. The results of this study can be used to map the status of soil quality in Kentucky which eventually helps farmers to manage the soils for sustainability.

Keywords: Acidity, bulk density, compaction, Kentucky, organic matter, tillage, water retention

Specified Source(s) of Funding: McNair Scholarship Program

Evaluating the Rhizosphere Microbiome Associated with Allelopathy of an Iconic Desert Shrub *(Poster Board #010)*

Caroline Plecki*, University of Arizona

Desert plants have evolved diverse tools for accessing limited water and soil nutrients, including inhibition of seed germination and growth of potential competitors. One tool for doing so is allelopathy – the exudation of compounds that inhibit the growth or germination of other plants. The desert shrub *Larrea tridentata* (creosote) is known for allelopathy and thus for forming monodominant stands of evenly spaced plants with few competitors in its extreme natural environments. Increasingly it is appreciated that plant microbiomes – the suite of microbes that live on, in, and in association with plant tissues – alter the chemical expression of their host plants. However, the potential roles of rhizosphere microbes in allelopathy are not well known. The aim of this study was to evaluate potential contributions of microbes to allelopathy of creosote. In phase one we surveyed the root microbiome of creosote in monodominant stands west of Tucson, Arizona, USA. Surveys encompassed aerobic, anaerobic, and oligotrophic microbes and were designed to provide a rich culture library that, after identification with molecular barcoding, was used in phase two (inhibition assays, designed to measure the capacity of these microbes, individually and in the context of infecting root tissue of creosote, to inhibit seed germination and growth of representative desert plants). Overall this study advances our understanding of the diversity of microbes associated with an iconic desert shrub and provides a first perspective on the capacity of microbes, or plant-microbe interactions, to influence the powerful allelopathic properties of one of the Southwest's most distinctive plants.

Specified Source(s) of Funding: Indigo Agriculture

Orchid Development and Mycorrhizae Fungi *(Poster Board #011)*

Kyle Kaps* and Adrienne E. Kleintop, Delaware Valley University

The Orchid family comprises of 32,000 species found throughout the world. Approximately 70% of species are tropical epiphytes. Orchid seeds lack a well-developed endosperm. In nature, orchids have a symbiotic relationship with mycorrhizae fungi which supply the nutrition needed for germination. In exchange for nutrients, plants give the mycorrhizae photosynthates for energy. Other than germination, little is known about what types of mycorrhizae are necessary for epiphytic orchid development and what roles they play in developmental stages of the orchid. This experiment was intended to demonstrate the symbiotic relationship between mycorrhizae fungi and orchids during seedling development. The objectives of the experiment were to: 1. Isolate mycorrhizae fungi from orchid roots 2. Determine the role of mycorrhizae in orchid seedling development. Four different orchid species were grown: *Dendrobium wattii, Laelia jongheana, Cymbidium devonianum, and Dendrobium tobaense.* Mycorrhizae fungi were isolated from the roots of *Miltoniopsis* orchids, and a commercial product containing four species of Mycorrhizae fungi was also cultured. The different orchid species were grown in sphagnum moss inoculated with the cultures of the two different mycorrhizae fungi. Two reps were planted in three treatments consisting of the two mycorrhizae fungi isolates and a control. Noticeable differences have been measured between the two mycorrhizae treatments and the control. This research may help commercial orchid growers to better transition orchid seedlings from tissue culture.

Effects of Commercial Fertilizers and Mycorrhizal Inoculants during Commercial Production of 'Mrs. Burns Lemon Basil' *(Poster Board #012)*

Leala M. Machesney*; Stephanie Burnett and Bryan J. Peterson, University of Maine

Hydroponic culture of plants is a multi-billion dollar industry that permits year-round production of crops. The components of many commercial nutrient solutions are unlisted, making it difficult to anticipate effectiveness. In contrast, the recipe for Hoagland solution, a standard fertilizer solution for research in hydroponics, provides a wide variety of plants with all required nutrients. In the first of two experiments, we evaluated 'Mrs. Burns' Lemon' basil (*Ocimum basilicum* var. *citriodora*) grown in deep water culture with one of three commercially available nutrient solutions [Advanced Nutrients pH Perfect Grow-Micro-Bloom (Advanced Nutrients), General Hydroponics Flora Series (Flora), or Remo Nutrients (Remo)] or half-strength Hoagland solution. Solutions were prepared to a concentration of 113 mg•L-1 nitrogen, while the concentration of other macronutrients and micronutrients varied. In the second experiment, we evaluated the effectiveness of mycorrhizal inoculants on basil growth. Although research supporting the colonization and effectiveness of mycorrhizal inoculants in hydroponics is scarce, mycorrhizae are sold for hydroponic production with claims of increased plant uptake of water, nitrogen, and phosphorous. To test colonization of endomycorrhizae and ectomycorrhizae, plants were cultured in either Remo or half-strength Hoagland solution with or without the addition of Root Magic Mycorrhizae (Blue Planet Nutrients) at the recommended rate of 0.27 g•L-1. In experiment 1, plants reached marketable size in five weeks, at which time SPAD was highest among plants in Advanced Nutrients and Flora and lowest among plants in Hoagland solution. Plants grown in Advanced Nutrients and Remo had the greatest heights, widths, and root and shoot dry weights, while plants grown in Hoagland solution were the smallest. In experiment 2, plant height did not differ between fertilizer treatments. However, plants fertilized with Remo had widths that were 40% greater and SPAD measurements that were 16% greater. Addition of mycorrhizae did not impact measures of growth in either nutrient solution. We conclude that fertilizer solutions differ in their effectiveness, and that inoculation with mycorrhizae is not beneficial for production of 'Mrs. Burns' Lemon' basil.

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Using Aquarium Test Strips and a Nix Pro Color Sensor to Precisely Determine Nitrate Runoff Concentrations from Containerized Plants *(Poster Board #014)*

Kenneth J. Sweeney*[1]; Kayla Howard[1]; Isabella Peedle[1]; Malcolm M Manners[2] and John L. Griffis Jr.[1], (1)Florida Gulf Coast University, (2)Florida Southern College

Nitrate runoff can be a serious problem for commercial nurseries, as nitrates lost from containerized crops during irrigation can contaminate ground water systems. Nitrates and other nutrients found in runoff water are also essentially wasted fertilizer and wasted money. There are numerous methods for measuring nitrate concentrations in water, although some of them are expensive, complicated, time-consuming and require the use of various isotonic reagents or toxic reagents that contain Cadmium. Aquarium test strips can be used to measure nitrate concentrations in runoff water as they are inexpensive, easy to use, and give a quick reading in just one minute. However, they can be difficult to interpret, since the color that develops on the strip has to be matched with color keys provided by the strip manufacturer. These color keys are not very exact; they only provide a few colors that match up with predetermined reference concentrations such as 10ppm, 25ppm, 50ppm nitrate. The user has to visually guess if the strip color matches one of the reference colors or if it is intermediate between two of them; that is not very precise. The precision of the aquarium test strips can be improved considerably if a Nix Pro Color Sensor is incorporated into the test procedure. The Nix Pro can determine the exact color (RGB, CIELAB, CMYK) not only for the printed color reference keys, but also for each test strip as it develops color after being dipped into the runoff solution. Additional nitrate stock solutions can be prepared for intermediate nitrate concentration values between those provided by the strip manufacturers (*e.g*. 8ppm, 12.5ppm, 14ppm, 17ppm nitrate, etc.) and the colors that develop on the test strips for those intermediate nitrate solutions can also be determined exactly. The colors that develop on the test strips from the runoff solutions can then be compared to the colors that developed from the various known nitrate concentration solutions. This technique allows for a simple, but much more precise determination of nitrate concentrations in the runoff water from containerized plants.

Specified Source(s) of Funding: Florida Gulf Coast University Foundation

Effect of Composted Animal Waste on Muskmelon (*Cucumis Melo* L.) Production on a Heavy Soil *(Poster Board #015)*

Willie Mims*[1]; Girish K Panicker[1]; Rebecca Becker[1]; Padma Nimmakayala[2]; Umesh Reddy[2] and Yan Tomason[2], (1)Alcorn State University, (2)West Virginia State University
Soil erosion and environmental pollution are the major problems the world faces today. Organic farming is the fastest growing sector in the field of agriculture due to environmental problems. As a part of the conservation research being carried out on horticulture crops for erosion prediction, nutrient management, and conservation planning, 103 varieties of melons (*Cucumis Melo* L.) from around the globe were analyzed for their quality and adaptability. Selected two varieties of high quality melons, Pride of Wisconsin and Charentais (French variety), were raised on Memphis silt loam soil (Typic Hapludalf, silty, mixed, thermic) in Southwest region of Mississippi. These melons received nutrients from three treatments of composted organic manures (cow-c; poultry-P; cow and poultry-c + p) in a split-plot design. Pride of Wisconsin was high in yield and stem diameter for all treatments, and high in Leaf Area Index (LAI) and percent canopy cover for cow + poultry. While Charentais was high in total number of fruits ha^{-1} for all treatments, it was high in dry biomass only for poultry manure. Fruit length, width, and seed cavity length were high for Pride of Wisconsin under poultry manure. Flesh pressure was high in Pride of Wisconsin for cow treatment. Even though not significantly different, the vitamin C content in Pride of Wisconsin was high for cow manure, followed by poultry, and least in C+P. Since both these indigenous and exotic varieties of melons respond well to these organic manures and are highly adapted to this region, we strongly recommend this farming system for our farmers.

Specified Source(s) of Funding: USDA/NIFA

Thursday, July 25, 2019

Growth Chambers and Controlled Environments 3 (Poster)

Improvement of the Real-Time Response Curve Estimation of the Canopy Net Photosynthetic Rate to the CO_2 Supply Rate in a Ventilated Greenhouse *(Poster Board #176)*

Takashi Kawashima; Ryo Matsuda* and Kazuhiro Fujiwara, The University of Tokyo
A greenhouse manager would supply CO_2 to the greenhouse, even in a highly ventilated greenhouse, if it were certainly cost effective to supply CO_2 at a certain rate. However, for a ventilated greenhouse, no useful index or criterion for the assessment of CO_2 supply cost effectiveness. We have proposed a response curve of the canopy net photosynthetic rate (CNPR) to the CO_2 supply rate (CSR) for a greenhouse on a cost-effectiveness assessment basis, with a novel procedure for real-time estimation of the response curve of CNPR to CSR in a ventilated greenhouse (CSR–CNPR curve). A greenhouse manager, based on a CSR–CNPR curve created with a short interval (a few minutes), can control the CSR to a greenhouse using a computerized greenhouse environment control system. To create a real-time CSR–CNPR curve for a short interval, PPFD, RH, temperature, CO_2 concentration inside and outside the greenhouse, the number of air exchanges per hour of the greenhouse, CNPR during the day, and canopy dark respiration rate during the night must be recorded, as the first procedure, for a short interval of more than 10 days after plants are transplanted into a greenhouse. A novel but slightly complicated second procedure to create a real-time CSR–CNPR curve using the recorded values described above was substantially improved from the firstly reported version. We will present the improved second procedure and results of a trial experiment with a small laboratory greenhouse, with a real-time CSR–CNPR curve created in accordance to the procedure.

Specified Source(s) of Funding: Commissioned Project Study on “the Research Project for the Future Agricultural Production Utilizing Artificial Intelligence”, Ministry of Agriculture, Forestry and Fisheries, Japan; JSPS KAKENHI Grant Number JP17K19306

Low Nitrate Leafy Vegetable Production in Plant Factory Condition. *(Poster Board #177)*

Takaya Saito*[1]; Nao Ando[1]; Hinano Okumura[1]; Yoshiaki Yamagishi[2]; Kai Iwasawa[2]; Tei-ichiro Kato[2]; Yasushi Yamamoto[2] and Takashi Ikeda[1], (1)Meiji University, (2)Ryonetsu Kogyou Co., Ltd.
We investigated how to reduce nitrate contents in leafy vegetables grown in plant factor conditions. It is well-known that excess nitrate has sometimes bad influence human health. It is noteworthy that it is relatively easy to control the concentration of nutrient solution at hydroponic culture. However, when plants were grown under low concentration of nitrate condition, it became light green and had no market value. Thus, to reduce the contents of nitrate in leafy vegetable, and keep fresh green, we investigated how to grow leaf lettuce (Lactuca sativa L. s. var. crispa) under controlled culture conditions (plant factory).
At five days before cultivation, we changed the nutrient solution to water, or cut the half amount of root, or cooled nutrient solution, and analyze the contents of nitrate in the lettuces. Also, we checked SPAD value for measuring concentrations of chlorophyll. As a result, we were able to reduce nitrate contents without decreasing SPAD value, by changing nutrient solution to water. This technique might be efficient for growing low nitrate contents of leaf lettuce in plant factories.

Physiological Responses of Spinach Subjected to Air Anions in Greenhouses *(Poster Board #178)*

Joung-Il An*[1]; So-Ra Lee[1] and Myung-Min Oh[2], (1)

Chungbuk National University, Brain Korea Center for Bio-Resource Development, (2)Chungbuk National University, Brain Korea 21 Center for Bio-Resource Development

Air anions stimulate various physiological processes and affect growth and development in plants. In our previous study, growth and mineral absorption of kale were improved by air anion treatment in a closed-type plant production system. However, the effect of air anions in the greenhouse has not been verified yet. In this study, therefore, we confirmed whether air anions could stimulate various physiological responses including growth in spinach cultivated in a greenhouse or not. The average air anion concentration of treatment was about 5.3 Ⅹ 10^5 ions·cm^{-3}, which resulted in positive effects on kale growth in our previous study. The air anion concentration of the control was about 5.7 Ⅹ 10 ions·cm^{-3}. After 2 weeks of germination, air anion generators were installed 40 cm above cultivation bed and spinach plants were cultivated for another 4 weeks. The shoot fresh weight of treatment was significantly higher than that of the control from 2 weeks to 4 weeks. Especially, 1.7 times higher shoot fresh weight was observed compared to the control at 4 weeks. Total leaf area and leaf number were also significantly higher in the air anion treatment at 2 weeks and 4 weeks than the control. The SPAD value indicating chlorophyll content was not significantly different at 2 weeks and 3 weeks but showed a sharp increase at 4 week of treatment. Root fresh weight and leaf shape index of treatment were significantly higher than the control at 4 weeks of treatment, too. The contents of total phenolics, total flavonoids and antioxidants in air anion treatment were 2.2 times, 1.4 times and 2.1 times higher than the control, respectively. In case of minerals uptake, the contents of most essential elements (P, K, Ca, Mg, S, Na, Fe, Cu, B, Al and Zn) except for Mn were significantly higher than the control. In conclusion, our results showed the possibility of application of air anions in commercial greenhouse cultivation.

Interactive Effects of Carbon Dioxide, Drought, and Temperature on Sweetpotato Cultivar Growth and Yield *(Poster Board #180)*

K.Raja Reddy*; Shasthree Taduri; Chathurika Wijewardana; Ajaz Lone; Stephen Meyers and Mark Shankle, Mississippi State University

Projected changes in climate warrant developing climate-ready agronomic crops. Among the abiotic stress factors, temperature and drought either alone or in combination impact crop growth yield. The objective of this study was to test the hypothesis that sweetpotato cultivars (Beauregard, Hatteras, and Louisiana 1188) differ in their responses to carbon dioxide concentrations (410 and 760 µmol mol^{-1}), temperature (30/22 and 38/30°C), and drought stress (well-watered, 100% evapotranspiration, ET and 50% ET) and their interactions. The control treatment consisted of 30/22°C temperature, 410 µmol mol^{-1} [CO_2], and well-watered plants (100% evapotranspiration). All other treatments were imposed at planting except irrigation treatments, which were imposed at 36 days after transplanting (DAP) and continued to 83 DAP. Plant growth and developmental parameters and plant-component dry weights were measured at the end of the experiment. Gas exchange, pigments, and cell membrane stability were measured several times during the experiment. Treatment variables significantly affected all the measured parameters in all cultivars. Cultivars differed significantly for many of the measured parameters. Well-watered conditions favored stem and leaf growth more than storage root growth. Elevated carbon dioxide ameliorated some of the damaging effects of drought and high temperature in all the cultivars. Elevated temperature either alone or in combination depressed storage root yield in all cultivars. Cultivars were classified based on total stress response index, developed from the cumulative sum of response indices of vegetative, physiological, and parameters. Among the three cultivars tested, Hatteras (+23.92) was classified as drought and temperature tolerant, and Beauregard (-12.61) and Louisiana 1188 (-12.67) were identified as drought and high temperature-sensitive. This analysis on limited number of cultivars suggests that large scale screening of sweetpotato germplasm for abiotic stresses are needed to develop climate-ready germplasm.

Marketing and Economics (Poster)

How Do Peach Growers Make Tradeoffs between Fruit Quality and Disease Resistance Traits?

(Poster Board #027)

Zongyu Li[1]; R. Karina Gallardo[2]; Vicki A. McCracken[1]; Chengyan Yue[3]; Ksenija Gasic[4]; Gregory L. Reighard[4]; James R. McFerson[5] and Xiangwen Kong[*3], (1)Washington State University, (2)WSU - Puyallup Research and Extension Center, (3)University of Minnesota, (4)Clemson University, (5)Washington State University, TFREC

Peach growers often face the challenge of growing peach cultivars that are disease resistant and in the meantime meeting the fruit quality needs of key supply stakeholders such as packers, shippers and consumers. The fruit quality traits include not only acceptable flavor, appearance, and eating experience, but also attributes like sustainable production practices and freedom from pesticide residues. This study used an economic experiment to explore how peach growers in the southeastern United States value fruit quality versus disease resistance traits. The results show that peach growers assign higher values to disease resistance compared to fruit size and external fruit color. Importantly, grower preferences for the same peach attribute varied depending on harvest time. The information obtained from this study will help peach breeding programs prioritize traits and develop cultivars that appeal to both supply chain stakeholders and growers.

Investigating US Strawberry Grower Willingness

to Pay for Fruit Quality and Disease Resistance
(Poster Board #028)
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Strawberry growers face production challenges given the incidence of diseases affecting their crops and consumers' increasing concerns about pesticide use in fresh fruits and the phase out of methyl bromide. Meanwhile breeders face a difficult challenge in combining production and consumer-oriented traits in a single new cultivar. Using economic experiments, we investigate how strawberry growers value disease resistance versus fruit quality. Our results indicate that depending on the fruit quality and disease resistance attribute considered, small and large growers might have similar or different preferences. Both small and large growers have strong preferences for the attributes flavor improvement and disease resistance from root and crown rot attributes. The findings from this study provide important information to breeders on identifying priority attributes for new cultivars for different types of strawberry growers. Such new cultivars will improve the competitiveness of the Florida strawberry industry in an increasingly competitive and marketplace.

Understanding Consumer Tastes, Preferences, and Willingness-to-Pay for Vegetable Soybean (Edamame) with Different Labeling *(Poster Board #029)*
Nick D Lord[*], Virginia Tech
Vegetable soybean, commonly referred to as edamame, is becoming commonplace in U.S. food systems. Despite its growing popularity, little is known about overall consumer familiarity and demand for edamame. With the majority of U.S. demand currently filled through frozen imports, marketing potential for various edamame end-products and labeling also remains poorly understood. In order to support growth of the domestic edamame industry, consumer demand for edamame must be extensively studied. Here, 222 consumer-intercept surveys were collected from three major shopping locales in Blacksburg, Virginia in order to explore consumer familiarity and willingness-to-pay (WTP) for edamame with fresh, local, and USDA organic labels. WTP is estimated using a contingent valuation method (CVM) following a one-and-one-half bound (OOHB) format at four price points ($3.25, $3.50, $4.00, and $4.50). Survey results confirmed edamame's popularity in the marketplace, as 66.7% of respondents indicated being moderately to very familiar with edamame. Interestingly, of the 42% of respondents who wished to reduce their meat consumption, 76% of them indicated health as a reason why, suggesting a potential target market for distributors given edamame's comparable protein quality to meat. WTP results indicate that edamame with fresh and local labeling hold highest marketing potentials with median WTP exceeding $4.50. Median WTP for edamame with USDA organic labeling fell between $3.50-$3.75, suggesting that it may not hold a significant marketing advantage over currently sold non-GMO edamame. WTP for on-the-stalk edamame was also studied, but low median WTP (<$3.25) suggests poor potential in the domestic marketplace.

Specified Source(s) of Funding: USDA Specialty Crops Research Institute (SCRI)

Categorizing Floral Consumers By Taste Preferences *(Poster Board #030)*
Melinda Knuth[*]; Xuan Wu; Charles R. Hall and Marco Palma, Texas A&M University
Floral designers have long been taught that the most important attributes of a design are its elements: line, color, texture, pattern, form, space, and size. Yet, these attributes have not been proven to be perfect indicators of consumer purchase behavior. Which of these elements are truly important to consumers and drives their purchase behavior? This study seeks to answer this question and thereby enhance the likelihood of floral purchases by determining how and if consumers place value in color harmonies, design symmetry, and the type of flower species included in the arrangement. This information can potentially increase sales for existing florists and for bouquet makers alike. This research is funded by the Floral Market Research Fund as the first of a three-part analysis of the floral industry. In Part 1 we dive into the elements and principles of design to discover what consumers find most appealing about a design. Part two analyzes floral website format. Part three applies the results of Part 1 and Part 2 into partnering business firms as a field validity test the findings. We are not gleaning more characteristics about generations in this analysis, but instead, we explore attitudes of floral purchasers relative to the elements and principles of floral design. The method of measurement used is eye-tracking technology in the Texas A&M University Human Behavior Lab to obtain the consumer's "eye view" of the elements of floral design. We test all elements combined in a discrete choice design. Ultimately, this analysis can tell us if the aspects the floral industry deems to be important align with the aspects the consumers perceive as important when purchasing floral products.

Specified Source(s) of Funding: Floral Market Research Fund

Nursery Crops (Poster)

Morphological Traits of Commercial Floricultural Interest in *Ratibida Columnifera* in Texas.
(Poster Board #368)
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Brent Pemberton[3] and Marco Palma[2], (1)Texas A & M University, (2)Texas A&M University, (3)Texas A&M AgriLife Research and Extension Center, Texas A&M University
Morphological Traits of Commercial Floricultural Interest in *Ratibida columnifera* in Texas.

Kaitlin Hopkins[1], Michael A. Arnold[1], Charles R. Hall[1], H. Brent Pemberton[2], and Marco A. Palma[3]

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Ratibida columnifera (Nutt.) Wooten & Standl. is an herbaceous perennial in the Asteraceae Brecht. & J. Presl family found in a large natural range in the United States, including highly diverse phenotypes in the Southcentral USA. This wildflower has the potential to be a viable nursery crop, but exhibits variation in both floral and vegetative characteristics, which limit its current commercialization potential. Online plant databases, such as the NRCS plant database and the Ladybird Johnson Wildflower Center plant database, provide some documentation and images of the many variations seen in nature of *Ratibida columnifera* in regards to flower and foliage morphology. Collection of unique wild germplasm and characterization of the cultural requirements of this plant could eventually facilitate breeding efforts and lead to a commercialized cultivars not yet seen on the market. This study focuses on the comparative morphology of wild germplasm collections from the native range of *Ratibida columnifera* in Texas. Collections of both vegetative cuttings and seed were accumulated during the 2018 growing season to develop a reserve of germplasm of plants with varying traits, including petal color, petal size, petal number, and petal shape. Upon growing out the vegetative cuttings, variation in foliage morphology was also discovered. Collection of these germplasms with varying marketable traits could potentially lay the groundwork for development of novel germplasms that may be fit for commercialization for the green industry once tested for market acceptance.

Specified Source(s) of Funding: NIFA (National Institute of Food and Agriculture)

The American Rose Trials for Sustainability® (A.R.T.S.®) Program Expands into More US Köppen Regions and Adds More Winning Roses *(Poster Board #369)*

David C. Zlesak*[1]; Michael Schwartz[2]; Gaye Hammond[3]; Randy Nelson[4]; Peter Kulkielski[5]; Allison Watkins[6]; Mark Chamblee[7] and Steve George[6], (1)University of Wisconsin, River Falls, (2)Naugatuck Valley Community College, (3) Houston Rose Society, (4)U of MN Extension Clay County, (5)Public Rose Garden Consultant, (6)Texas A&M AgriLife Extension, (7)Chamblee's Roses

American Rose Trials for Sustainability® (A.R.T.S.®) is a US rose trialing program initiated in 2012 after the disbanding of the All-America Rose Selection (AARS) program. A.R.T.S.® trials newer roses in the marketplace using scientific methodology (blocking, randomization, control cultivars, etc.) under low input conditions with the goal of identifying and promoting regionally adapted rose cultivars. Trial sites are located in an increasing number of continental US Köppen climatic regions (8 of the 9 regions are represented in 2019) with collaborators hosting sites at botanical gardens, city parks, and universities. Roses that score higher than the mean of the control cultivars in each region earn a regional Local Artist award, and roses earning four or more Local Artist awards are recognized as Master Roses. Roses are scored monthly during the growing season and are rated for several traits related to floral attributes (42.5% of score), foliar health and quality (45%), and growth habit (12.5%). A.R.T.S.® is led by a group of volunteer rose experts representing university scientists, public gardens, nurseries, and rose societies. The program is in its third season of announcing winning roses (2018-2020) with a total of 29 roses earning Local Artist awards (12 of these earned the Master Rose award). A.R.T.S.® has successfully transitioned to a 501(c)(3) nonprofit, and ongoing program goals include: having two trial sites in all nine continental US regions, expanding marketing efforts for increased program recognition, and increasing program revenue to support current and new expenses.

A Dynamic Laser-Guided Sprayer Reduces Pesticide Use in Large Pot-in-Pot Production *(Poster Board #370)*

Lauren Fessler*[1]; Amy Fulcher[1]; James Hines[2]; Heping Zhu[3]; Terry Hines[2]; Wesley Wright[1]; Whitney Yeary[4]; Sun Xiaocun[1] and Sterling Mcclanahan[1], (1)University of Tennessee, (2)Hale & Hines Nursery Inc, (3)USDA-ARS Application Technology Research Unit, (4)UT

A recent groundbreaking advance in spray application technology, the ability to customize the application using scanning laser rangefinder measurements and variable-rate solenoid valves can be retrofitted to existing air-blast sprayers, allowing growers to access the technology without purchasing a new sprayer. This technology detects plant presence, size, and density and adjusts spray output to match crop characteristics in real-time. Multi-row blocks provide a unique performance environment for the laser-based sensing system; therefore, the objective of this experiment was to compare sprayer performance and volume, and pest and beneficial insect populations in the manual and "intelligent" spray modes when applied to 15-gallon trees in a multi-row block, pot-in-pot production system.

For this experiment, a field was divided in half, with one half sprayed in intelligent mode applying 0.07 fl. oz./ft^3 (0.07 L/m^3) and the other in manual mode applying 51.3 gallons/acre (480 L/ha), a conservative rate compared with the industry standard of 100 gallons/acre (935 L/ha). Ten Shumard oaks were flagged in each treatment and monitored regularly for Cylindrosporium and Tubakia leaf spots. Half of the trees were in an outer row of a block and half in an interior row. Presence and number of pollinators and natural enemies were also recorded. On August 8, 2018, water sensitive cards were placed in the tree canopies and at the base of flagged trees and then sprayed with water to assess intentional and non-target spray with one pass down the driveway, spraying cards from one direction. Cards were analyzed for coverage (%) and droplet density (deposits/cm^2). Spray volume consumed was recorded for each treatment (sprayer mode).

Shumard oaks increased in caliper 0.05 in (1.3 mm) and 0.12 in (3.0 mm) for the manual and intelligent modes, respectively, from August 4 to November 16, 2018 and were not affected by sprayer mode or row position (*P*-values 0.0548 and 0.5008, respectively). The average spray volume consumption was 102 gallons (387 L) for the manual and 72 gallons (272 L) for the intelligent mode, a 30% reduction (*P*-value <0.0001). Pest population levels and pest damage were managed to an acceptable level in both treatments. Few natural enemies and pollinators were observed, regardless of treatment. Within the canopy, pesticide application deposit density met or exceeded the recommended guidelines for both modes (20-30 droplets/cm^2 threshold for insecticides, 50-70 droplet/cm^2 threshold for fungicides). Coverage and deposit density did not significantly differ between sprayer modes (*P*-values >0.05); however, volume used in the intelligent mode was significantly less indicating the intelligent sprayer technology can achieve recommended pesticide application ranges while reducing pesticide costs and the potential for negative ecosystem impacts.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant

Characterization of Water-Soluble Phenolic Acids from Pine Bark Media *(Poster Board #371)*

Magdalena Pancerz*, Ohio State University; James Altland, USDA-ARS, MWA ATRU and C. M. Ranger, USDA-ARS

Pine bark is the most common substrate used in container production of nursery crops. Previous studies have demonstrated an improvement in plant health from cultivation in pine bark media, which could be a function of beneficial microorganisms colonizing the bark and inferring resistance to bacterial, fungal, and viral diseases. Yet, little attention has been paid to the chemical composition of leachate associated with pine bark media. Phenolics are known to have positive or negative effects on plants growth and health depending on their chemical composition. Thus, the aim of this research was to identify water-soluble phenolic compounds in pine bark extract as a precursor to testing the effects of specific compounds on plant health in container culture. Pine bark was mixed with water in 1:1 (v:v), stirred for 24 hours, then filtered to remove solids. The aqueous extracts were then subjected to a liquid-liquid extraction with ethyl acetate (1:1, v:v). The organic fraction was concentrated under vacuum, reconstituted in 10% methanol (aq), and analyzed using ultra-performance liquid chromatography-mass spectrometry with multiple reaction monitoring. A variety of phenolic acids were identified in water-soluble extracts from pine bark, including benzoic acid, caffeic acid, *p*-coumaric acid, ferulic acid, gallic acid, gentistic acid, 3- and 4-hydroxybenzoic acids, *p*-hydroxyphenylacetic acid, salicylic acid, and vanillic acid. Some of these compounds, including salicylic acid, are known to benefit plant health, which will be addressed in subsequent studies.

Organic Horticulture (Poster)

Effect of Several Organic Fertilizers for Growth and Market Quality in Maize *(Poster Board #058)*

Sung-Hee Lee*, Chungcheongbuk-do Agricultural Research and Extension Service

The purpose of this study was to investigate the effects of some organic fertilizers for the organic cultivation of maize and selection of a substitute for oil-cake in Goesan, Chungbuk province in 2018. As a result, nitrogen, phosphoric acid, potassium, calcium and magnesium contents of each organic fertilizer were in the order of oil-cake > amino acid fertilizer > fermented liquid fertilizer = compost tea. Each of these organic fertilizers had little influence on the chemical change of soil, but amino acid fertilizer and oil-cake for weight of an ear as well as all treatments for the fresh weight of 100 kernels showed significant increase, compared to the untreated control. After all, the market quality of corn from each treatment was in the range of 83.2~86%, which was improved by 2.5~5.9%. On the other hand, as a result of mixed treatment of amino acid fertilizer and compost tea to explore a substitute for oil-cake, the change of chemical property of soil was insignificant. The mixed treatment, nonetheless, showed significant increase for stem height to 1st ear, grain setting length in an ear, weight of an ear, and fresh weight of 100 kernels, compared to the control. After all, the market quality of corn by the mixed treatment was 91.2%, which was 3.9% higher than the control. Therefore, our study is considered that the mixed treatment of amino acid and compost tea is an organic material that can replace oil-cake in maize.

Specified Source(s) of Funding: This work was carried out with the support of "Cooperative Research Program for Agriculture Science and Technology Development (Project No. PJ012530042019)" Rural Development Administration,

Republic of Korea.

Comparison of Consumer's Perception and Instrumental Analysis of the Bagged Organic Peaches in Southeastern United States *(Poster Board #059)*

Juyoung Kim[1]; Juan Carlos Melgar[*2]; Koushik Adhikari[1] and Dario J. Chavez[1], (1)University of Georgia, (2)Clemson University

Fruit bagging, which has been a common pre-harvest method in Asia, is getting popular in the West. It is a promising method to lessen the pesticide usage due to its protective function. Its effect on the sensory properties of the fruit and how the consumers perceive it are not fully studied. Since consumers are the ultimate decision maker, it is important to find out how they perceive organic bagged peaches. A consumer test (n = 111) was conducted to determine acceptability and consumer perception of bagged organic peaches (cultivar 'Julyprince') along with the instrumental analyses. Compared to conventionally-grown organic peaches, bagged peaches had a significantly smaller size, less weight, higher L value for the light side of the skin, greater Kramer shear force, and a higher aroma liking score. However, there were no significant differences in the degrees Brix, pH, total titratable acidity, compression, puncture, and liking scores (appearance, flavor, sweetness, sourness, and texture). The majority of consumers considered buying peaches from the nearby/local areas as important. Among the characteristics of peaches, consumers considered appearance (damaged/defective/bruised), firmness, and presence and strength of aroma as the key characteristics. Considering that most fruits on the market get pre-sorted if their appearance or texture are defective, aroma of the peach fruit can be considered as the most important characteristic when purchasing peaches. Most of the consumers (69%) had not heard about 'Bagged Peaches'. After being informed about what they are, their advantages, and disadvantages, 63% of the consumers expressed their attitude toward bagged peaches as positive, 59% showed they are likely to become a regular consumer of bagged peaches, and 47% answered that they are willing to pay more for 'bagged peaches' in the market. Bagged peaches grown in Southeastern region of U.S. could be competitive on the market satisfying consumer's need of purchasing locally grown fruit and having acceptable aroma even with slightly higher cost.

The Effects of Microclimate Modifications and Crop Yield and Quality in Organic High Tunnels *(Poster Board #060)*

Savanah Laur*, The Unviersity of Georgia and Timothy W. Coolong, University of Georgia

Many growers use high tunnels to extend their growing season. In the fall however, crops are often planted during warm weather in high tunnels, subjecting them to heat stress early in development. Growers have employed shade cloth as well as fogging systems to reduce heat stress in fall-planted high tunnels. The present study evaluated the impact of shade cloth and a micro-fogging system on arugula (*Eruca vesicaria*), basil (*Ocimum basilicum*), and lettuce (*Lactuca sativa*) planted in September and early October in high tunnels in Athens, Georgia. While 30% shade cloth reduced day-time temperatures, it reduced yields in the October planted crops compared to non-shaded crops, suggesting that light levels were limiting at this time. The fogging systems did not significantly decrease average day time temperatures, but did increase soil moisture content and humidity. There were no significant effects of fogging system on yield of the crops grown. However, high humidity levels in the tunnels may have contributed to disease pressure due to basil downy mildew (*Peronospora belbarhrii*). Planting date also affected crop yields. October planted crops yielded lower than those planted in September, suggesting that the shade cloth and micro-fogging system were unnecessary in the cooler, shorter days, experienced later in the fall season.

Surveying Soil Health in Organic, Conventional and Natural Croplands – a 7-Year Study *(Poster Board #061)*

William Sciarappa*; Stephanie Murphy; Dennis McNamara and Kevin Akey, Rutgers University - NJAES

A 7-year soil health survey from 2012-2018 assessed soil chemistry and microbial respiration in the rhizosphere of a diversity of horticultural systems. Over 1000 soil samples of both annual and perennial crops were compared in organic and conventional farms and native forestlands. Representative crop categories of vegetable crops included sweet corn, pepper and tomato; agronomic crops were field corn and soybeans; small-fruit crops were blueberry and strawberry; grass crops included equine pasture, bioenergy grasses, home-lawns and golf-course greens/fairways. Soil probes were inserted 6-8 inches deep with 8 sub-samples per replication. All sites had similar sandy loam or clay loam soils such as Sassafras, Downer and Berryland types. Chemical laboratory analysis and estimated crop needs are used to recommend fertilizer rates. Not typically measured is the ability of farmland soils to produce their own nutrients such as nitrogen through mineralization by soil microbes. This biological process is a key factor in soil building methods used in organic and sustainable farm production. The Solvita® CO_2 aerobic respiration test measured the release of carbon dioxide from the soil as a measure of microbial biomass and nitrogen nutrient mineralization. Among the grass crops, the perennial bio-energy crop, *Miscanthus giganteus*, had the highest CO_2 burst of 23 ppm; similar to field corn-soybean-cover crop rotations but significantly different at P>.05 than the 11 ppm of golf course bent-grass greens, *Agrostis stolonifera.* Sweet corn, *Zea mays* convar. *Saccharata* var. *rugosa* were slightly higher at 14.0 ppm. Untilled, perennial sites as golf course fairways, equine pastures and residential lawns, all with bluegrass mixes, *Poa pratensis*, averaged

An asterisk (*) in front of a name indicates the presenting author.

higher at 21 ppm. Significantly higher soil respiration levels averaging 37, 41, and 31 ppm reached an ideal microbial activity and soil health. These results were achieved in organic blueberry operations (*Vaccinium corymbosum*), natural forestlands and organic lawns with no-tillage and standard practices like "feeding the soil" with composted amendments. Conversely, most conventional blueberry soil respiration levels were under 10 ppm. Significant correlations were found with increased pH and higher organic matter. These related high levels of microbial CO_2 respiration can return 30-40 lbs. of naturally produced nitrogen per acre per year. This low-cost, biological soil test may be used to measure any changes over time from farm management practices such as cover cropping, tillage systems, fertilizers, liming, municipal leaf additions and organic compost amendments.

Specified Source(s) of Funding: New Jersey Soybean Council, Monmouth County Board of Agriculture, Rutgers University NJAES-RCE

Evaluation of a Field-Scale Steam Applicator in California Strawberry Fruit and Nursery Fields. *(Poster Board #062)*

Steven A. Fennimore* and Dong Sub Kim, University of California, Davis

There is market demand for organic produced strawberry nursery plants as well as fruit. However, the risks to plant and fruit producers to grow on non-fumigated land is significant as diseases and weed infestations can be costly or devastating to the crop. Soil disinfestation in field with steam is possible on limited areas, but there are engineering issues to overcome. The objective of this work was to evaluate the performance of a prototype field-scale steam applicator. In August and September 2018, we tested a prototype field steamer for soil disinfestation in high-elevation strawberry nursery fields in Northern California, and in fruit fields near Salinas, and Watsonville CA. The steam applicator consisted of a 300 hp Cleaver Brooks steam generator mounted on a trailer towed by a tractor. Steam was injected into a 3 m wide rototiller set to till 40 cm deep. Target temperatures and dwell times were 65°C for 20 minutes. Real-time soil temperatures were measured with Hanna K-type thermocouple thermometers set at 20 cm deep. Hobo Soil temperature recorders were placed immediately behind the steam applicator and left for 24 hours to measure soil temperatures at 10, 20, 25 and 40 cm depths. Soil samples were gathered before and after steam application. Fumigants were used to compare against steam in four out of five test sites. At fruiting sites, steam was applied alone and co-applied with 3,368 kg ha^{-1} mustard seed meal (MSM). Weed seed samples in sachets were buried at Salinas only at depths of 15 cm.

Following steam application at Salinas and Watsonville, maximum soil temperature reached 73 and 67°C and time of above 65°C was 108 and 52 minutes, respectively. The steam applicator increased soil temperature of 65°C at a depth of 25 cm for 63 minutes at Salinas and 12 minutes at Watsonville. At Salinas, viability of purslane seeds and microsclerotia population of *Verticillium dahliae* in the no steam control, MSM alone, steam alone, and steam + MSM were 78, 86, 3 and 1% and 688, 553, 1, and 0.2 microsclerotia g^{-1}, respectively. At Watsonville the percentage reduction in *Pythium ultimum* by steam alone and steam + MSM was100 and 96%, respectively.

After steam was applied at Sierra Cascade, Plant Science, and Lassen canyon nurseries, maximum 25 cm soil temperature was 71, 66, and 80°C and time of above 65°C was 106.5, 32.5, and 180 minutes.

Specified Source(s) of Funding: USDA NIFA Methyl Bromide Transitions

Ginger Development from Transplanted Seedlings and Rhizome Pieces in Different Organic Nutrient Sources *(Poster Board #065)*

Lurline Marsh*, University of Maryland, Eastern Shore and Brett Smith, University of Maryland Eastern Shore

Ginger (Zingiber officinale, Roscoe) is a tropical rhizome crop used as a culinary and medicinal spice, and an antimicrobial agent. It also contains essential oils (volatile oils) and oleoresins which represent the aroma and flavor, respectively, as well as antioxidants. In the northeast USA, the plants are grown in high tunnels to produce baby ginger as a niche crop. Typically, ginger is grown from rhizome pieces, called seed sets, but can also be produced from vegetative plantlets, called "seedlings" derived from mother rhizomes. Since these seedlings have more advanced stem and leaf development than the seed sets, their use in production may accelerate plant development over these rhizome pieces. No information is available on how the seedling method compares with the rhizome piece method in ginger organic culture. Therefore, the objective of this study was to assess crop development of organic ginger produced from rhizome pieces and seedlings under different nutrient sources in high tunnel. Three types of propagules; single shoot transplant seedlings derived from 36.5-40.0 gm/rhizome, multiple shoot transplant seedlings derived from 60 -120 g rhizome, and seed sets of 60 -120 g; and 3 nutrient regimes; Cotton seed meal (1,640 lbs./ac.) plus Azomite (8,712 lbs/ac.), Nature Safe (630.7 lbs./ac.) and Phytamin All Purpose Liquid fertilizer (1 gallon/ac.) were used. Nutrient rates were calculated based on ginger nitrogen requirements of 82 lbs./acre. The design was a split plot with nutrient as main plot and type of propagule as subplot and with 4 replications. Plants from seed sets were shortest and had largest number of tillers at harvest at 5 months (June 21-December 10) after transplanting; those from multi shoot seedlings produced the most rhizomes (381gm/plant), and single shoot seedlings produced the lowest yield (235g). Leaf SPHAD at one, two and three months after transplanting did not differ among the treatment combinations, and ranged from 43 to

46. Phytamin treated plants produced the most tillers while Nature Safe fertilized plants had the least. Fertilizer did not affect yield, which ranged from 343 gm for Phytamin treated plants to 252 gm for Nature Safe plants. These results suggest that for best rhizome yield, selecting seed sets or multiple shoot seedling is a better option than using single shoot seedlings.

Specified Source(s) of Funding: Evans Allen

A Non-Chemical Approach for Controlling Panama Disease Occurrence in Taiwan with the Essential Oil of *Biden Pilosa* *(Poster Board #066)*

Zhong-Bin Wu*[1]; Ying-Hong Lin[2]; Anren Hu[3]; Fen-Lien Chi[1] and Jyh-Shyan Tsay[1], (1)National Taitung Jr. College, (2)National Pingtung University of Science and Technology, (3)Tzu Chi University

Panama disease caused by *Fusarium oxysporum* f. sp. *cubense* (FOC) is the most destructive disease in banana production. In this study, we explore a potential non-chemical approach to reducing the incidence of Panama disease in fields in Taiwan. Fresh materials collected from 11 naturalized or invasive plants were subjected to steam-distillation, and the isolated essential oils or hydrosols were subsequently evaluated for *in vitro* antifungal activity against three FOC reference isolates: YJL-F040 race 1, ATCC-76243 race 2, and ATCC-38741 subtropical race 4. The essential oil of the *Biden pilosa* plant demonstrated potent antifungal activity against FOC isolates, showing 22% to 43% inhibition of mycelial growth in races 1, 2, 4, and 70% inhibition of spore germination in race 4. A preliminary field experiment was then conducted in an orchard in Taitung County, Taiwan, and the area was divided into four sections, and one testing area and three control areas were randomly assigned. A re-dissolved 0.01% (v/v) solution prepared from the essential oils and hydrosol of *B. pilosa* plants were irrigated into the bulk soil areas of 84 banana plantlets during secondary hardening, once a week beginning March 13, 2017. The incidence of Panama disease was investigated from August 28 to November 15, 2017. Disease incidence was just 16% in the testing area, compared to 53%, 51%, and 12% in the three control areas. A second investigation was carried out on four different orchards from March 20, 2018 to December 21, 2018. Incidence rates of Panama disease were 22.2% to 27.3% in the testing areas and 45.2% to 62.2% in the control areas. In-depth analysis of the antifungal compounds in *B. pilosa* essential oils was carried out with gas chromatography–mass spectrometry (GC-MS). Our results suggest a promising non-chemical approach for controlling the occurrence of Panama disease using *B. pilosa* essential oils.

Specified Source(s) of Funding: Agriculture and Food Agency, Council of Agriculture, Executive Yuan, R.O.C. Taiwan

Introductory Organic Agriculture Curriculum for Undergraduate Students *(Poster Board #067)*

Samantha Nobes*; Makenzie Pellissier and Randa Jabbour, University of Wyoming

Organic agriculture course offerings continue to become more common at colleges and universities in the United States, and often reflect instructor expertise or regional issues of concern. The goal of this project was to develop multi-regional organic agriculture undergraduate curriculum at the introductory level for diverse student audiences. We interviewed 19 faculty members that teach on the topic of organic agriculture to identify the most important concepts and skills students should grasp. Respondents varied across position type, department, institution type (including land-grant and non-land grant), and years of experience teaching on the topic of organic agriculture. Based on their responses, we developed a working framework adapted from the Next Generation Science Standards. Within this framework, we created teaching modules for the following critical and needed topics: certification, organic history, and social dimensions. These modules include lesson plans, supplementary materials, and resource lists. We also have additional lesson plans for organic seed, organic pest management, and marketing. Original short films based on interviews with six certified organic farmers and ranchers are used throughout the modules and are available at bit.ly/orgproducer. Three of the interviewed farmers are focused on vegetables, fruit, and/or flower production. Module testing consisted of use of all resources in a single class at the University of Wyoming, and sharing individual modules with participating faculty from other institutions to seek feedback. All modules are available at the Sustainable Agriculture Education Association website, in their teaching resources library. Project made possible with funding from the USDA National Institute of Food and Agriculture Organic Agriculture Research and Extension Initiative #1007232.

Specified Source(s) of Funding: OREI

Online Undergraduate Certificate in Organic Farming Systems at Oregon State University *(Poster Board #068)*

Alexandra Stone* and Javier Fernandez-Salvador, Oregon State University

Organic agriculture is a federally defined and regulated agricultural and food system that is growing rapidly. The global market for organic food reached $89.7 billion in 2016. The United States is the leading market with $47.9 billion. Most major markets continue to show double-digit growth rates. There is a critical need for people with technical training in the science, practice, and regulations related to organic agricultural crop production.

In an effort to fill this educational need, Oregon State University will begin offering an online Undergraduate Certificate in Organic Farming Systems in Fall 2019. The over-arching learning outcomes of the program are to 1) understand and communicate the principles, practices, science, and outcomes of organic agriculture to diverse audiences, 2) apply science- and practice-based information to design, evaluate and problem-solve in organic systems, and 3) analyze the ripple effects of organic production and/or purchasing decisions on the three dimensions of sustainability (society, environment, economy). The certificate is a skills-based program emphasizing organic management of soil, insects, diseases, weeds, and supplemental inputs. Students will learn how to find and evaluate quality of organic management information and develop and evaluate soil, insect, disease and weed management plans. In addition, students will gain an understanding of the regulations, policies, economics, and social implications of organic farming systems. "Systems thinking" will be cultivated to help students see interconnections and understand how management decisions influence sustainability (environmental, social, and economic). The certificate program is a 27 credit interdisciplinary minor. Undergraduate students will enroll in the certificate program as a complement to their major; post-baccalaureate students can enroll solely in the certificate program. All students must complete pre-requisite courses in soil science, plant pathology, and entomology. Required courses:

CROP 355. Organic Certification (3)

HORT 212. Introduction to Organic Systems (4)

HORT 306. Inputs in Organic Cropping Systems: Sourcing and Efficacy (2)

HORT 307. Organic System Predicaments (3)

HORT 308. Weed Management in Organic Cropping Systems (3)

HORT 344. Insect and Disease Management in Organic Cropping Systems (3)

HORT 482. Design and Management of Organic Cropping Systems (Capstone) (3)

SOIL 360. Soil Management for Organic Production (3)

AGRI 411. Introduction to Food Systems: Local to Global (3)

Oregon State University Ecampus has been named a top 10 online college by US News and World Reports for five years. This program will utilize best practices in online education to reach diverse students around the globe.

Trellis Systems Affected the Growth and Yield of Four Eggplant Cultivars in an Organic High Tunnel in North Carolina *(Poster Board #069)*

Sanjun Gu*; Tekan Rana; John Kimes and Randy A. Fulk, North Carolina Agricultural and Technical State University

High tunnels benefit small farmers by extending the growing, harvesting and marketing seasons of specialty crops. To maximize the benefits, farmers need to efficiently use the space in a high tunnel. Eggplant is one of the important vegetables of great culinary value. Grown in high tunnels, eggplants will add produce diversity and potentially increase profits for small producers. Information on high tunnel eggplant production has been limited. The objective of this trial was to exam the effect of trellising and training on the performance of high tunnel eggplants. Cultivars Clara, Nadia, Oriental Express and Traviata were trellised with either the Florida Weave system (FW) or Tomato Rollerhook® system (RH). Suckers of plants with FW were removed up to the node of the first female flower. Plants with RH were pruned to one leader by removing suckers all season. On May 25, 2017, transplants were planted into a plasticulture system of 30"-wide raised beds covered with black plastic mulch and with double-row drip tapes, in a 30'(W) x 96' (L) high tunnel on A&T University Farm in Greensboro, NC (hardiness zone 7). In-row and row spacing were 18". The trial was conducted as a split-plot design, with the trellis system as main plots and cultivars as split plots. There were three replications, six plants per replication. The trial wrapped up on October 26. Eggplants trellised by FW had significantly higher marketable yield and fruit number (4.0 kg and 23.1 fruit per plant) than by the RH system (1.5 kg and 8.2 fruit per plant). Plants trellised with RH had significantly taller plants ((220.4cm) than that with FW (188.1cm) at the last harvest. The trellis systems did not affect the date of first and 50% flower and the plant height at 50% bloom. Although there was no difference among cultivars regarding the marketable yield, significant differences existed in terms of time of blooming, 1st harvest, number of nodes at 50% bloom, and plant height at the 50% bloom.

Identification of Plant Endophytes for Biological Control Agents of Macrophomina Root Rot in Snap Beans *(Poster Board #070)*

Margaret T, Mmbaga*, Tennessee State University and Jacqueline Joshua, Bayer Chemicals

Snap beans *Phaseolus vulgaris* L. often referred to as 'French' beans, 'string' beans or 'green' beans is the most cultivated vegetable in home gardens and the third most valuable vegetable in the US following tomatoes and sweet corn. The majority of snap bean production across United States occurs in the southern states (Florida, Georgia and Tennessee). In Tennessee, snap beans ranked second in economic importance with a value of $18,368,000 in 2015. However, root rot pathogens including *Pythium, Rhizoctonia, Fusarium, Phytophthora, Sclerotium rolfsii* and *Macrophomina phaseolina* are among major constraints in snap bean production. Although fungicides provide some protection against most root rot pathogens, fungicides are detrimental to the environment and non-target beneficial microorganisms; repeated use has also been linked to fungicide resistance leaving limited options for growers. The objective of this study was to evaluate the ability of previously selected microorganisms as biological control agents (BCAs) against *M. phaseolina* root rot in snap beans. Endophytic bacteria that colonize plants internally are likely to be effective in field environment al where fluctuationsin temperature, moisture and UV light affect the efficacy of biological control agents. Six bacteria were evaluated in-vitro using dual culture technique and in vivo in greenhouse and two were evaluated in field environment. The BCAs inhibited pathogen colony growth by 43-75%. Seed treatment with the BCAs showed IMC8 and Y (*B. thuringiensis*), Prt (*B. subtilis*, Psl (*B. amyloliquefaciens*), Ps (B. *vallismortis*) were more effective in suppressing *M. phaseolina* than the fungicide tetramethylthiuram disulfide (thiram) in greenhouse studies. Only two BCAs were tested in field environment and both *Enterobacter* sp. and *B. subtilis* were as effective as the fungicide in reducing disease incidence and improving seed germination in field experiments.

Specified Source(s) of Funding: USDA/NIFA Award No. 2010-38821-21477

Ornamental Plant Breeding (Poster)

Imparting Cold-Hardiness into Begonia through Interspecific Hybridization *(Poster Board #281)*

Hideka Kobayashi*, Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems

The genus *Begonia* is one of the largest flowering plants. Over 1,900 *Begonia* species have been described with many more species undescribed. Several important horticultural groups of Begonia hybrids have been developed, including cane types, rhizomatous types, tuberous types, rex begonia, wax begonia, and *B*. x *hiemalis*. While *Begonia* species are found mostly in subtropical and tropical areas, some are native to temperate regions. Most of these temperate plants are from high altitudes in China, India, and surrounding countries, and have relatively limited distribution. One exception is *B. grandis*, which is probably the most cold-hardy species, with a distribution from northern China to Bangladesh to the west and Malaysia to the south. There has been a moderate interest to develop *Begonia* hybrids with cold-hardiness to extend the growing season or to even perennialize. There are mainly three problems with *B. grandis* for its use in breeding: compatibility with other species, availability of compatible species, and heritability of cold-hardiness. While most *B. grandis* hybrids do not display substantial cold-hardiness, one *B. grandis* hybrid, *B*. 'Smooch,' is purported to be a hybrid with a Taiwanese species (*B. chitoensis*) and cold-hardy to USDA Cold Hardiness Zone 6a, suggesting the possibility of developing fully cold-hardy *Begonia* hybrids. In the section *Platycentrum*, several species of unknown identities and hybrids such as *B*. 'Benictochiba' and *B*. 'Silver Series™' can survive in USDA Cold Hardiness Zone 7 or above. Species in the section *Platycentrum* and hybrids are notable for attractiveness of their foliage, which should be considered when developing hybrids. Thus, various combinations of crosses involving *B. grandis* have been made and germination rate has been recorded to investigate the compatibility of *B. grandis* with species in the section *Platycentrum* as well as others. To this date, seedlings of several crosses such as B. grandis 'Heron's Pirouette' x *B. ningmingensis* var. *bella*, *B. grandis* 'Sapporo' x *B. muliensis*, and *B. formosana* x *B*. 'Chandler's Hardy,' have been acquired.

Specified Source(s) of Funding: USDA Evans-Allen Research Program

Developing Triploid Hardy Hibiscus (*Hibiscus moscheutos*) *(Poster Board #282)*

Kaitlin Barrios* and John M. Ruter, University of Georgia

Hardy hibiscus (*Hibiscus moscheutos*) is a native perennial plant with strong ornamental qualities such as large, showy flowers, continual summer blooming, and a rounded shrub habit. Hardy hibiscus (2n=38) is a pleasing landscape plant with a wide growing range (hardy in USDA zones 4a-9b), and reasonable fertility, producing many fruit and seed. To prevent reseeding and potentially extend the bloom period by eliminating fruit and seed production, the development of sterile plants was trialed. Sterile plants can be created by developing triploid progeny, which are typically sterile or have greatly reduced pollen viability. Eleven advanced, experimental lines and two commercial cultivars were used to obtain 12 families of intraspecific seed in summer 2016. Plants were chosen for aesthetic characteristics, such as red foliage, red stems and petioles, and compact or reduced size, and for enhanced tolerance of hibiscus sawfly (*Atomacera decepta*). Seed was sown in early spring 2017 and once the germinating seedlings had fully-expanded cotyledons, they were soaked in a 100 mM oryzalin solution on a rotary shaker for either two or four hours. A total of 594 seedlings were treated for two hours and 586 seedlings for four hours over nine different dates between 14 June and 17 Aug. 2017. Oryzalin was applied for its inhibitory effects on the spindle fibers during mitosis, thereby acting as a chromosome-doubling agent. Plants were allowed to recover and ploidy level was evaluated via flow cytometry in summer 2017. Plants having double the chromosome number of the species were used as female parents once they began flowering, and untreated, breeding lines were used as pollen parents in hand-pollinations made from Jan. to Sept. 2018 to produce triploid seed. Putative triploid seed was collected and seedlings were tested via flow cytometry. Seventy-five hibiscus plants from 11 crosses have been confirmed as triploid by flow cytometry and were planted in the field. Remaining putative triploid seed (2,000+) will be sown spring 2019 and resulting plants will be evaluated for triploid status and cultivar potential in summer 2019. Results show the applicability of developing triploid plants using polyploidy induction with chemical mutagens and triploid selections will be presented.

Specified Source(s) of Funding: Star Roses and Plants

Morphological Trait Variation in the Arctic Daisy, *Chrysanthemum Arcticum* *(Poster Board #283)*

Yunjia Liu* and Neil O. Anderson, University of Minnesota
Chrysanthemum arcticum and its two subspecies (*C.a.* subsp. *arcticum, C.a.* subsp. polare) are the only *Chrysanthemum* species native to North America. The centers of origin and diversity are the State of Alaska. This species is salt tolerant, growing only in coastline areas, as well as in acidic soils. *Chrysanthemum arcticum* may be endangered and is of interest for conservation as well as for evolutionary and genetic studies and a source for new product development. Its dwarf and spreading plant habit plant would be useful to incorporate into new series of winter-hardy, ground-cover types. Our research objectives were to characterize and quantify plant morphological traits existing in extant populations from the Aleutian Islands and mainland Alaska. Clones from extant populations of *C. arcticum* and *C.a.* subsp. *arcticum* were used in this study. Morphological traits examined for phenotypic variation included the number of days to visible bud (VBD) and flowering, plant/stem/inflorescence height, flower diameter and petal length, number of leaves and internode lengths, as well as leaf morphology. After 6 weeks (1000 hrs) of cold, VBDs of *C.a.* subsp. *arcticum* occurred as early as 28 d while flowering commenced 9 d later (37 d) under long days; *C. arcticum,* however, took longer for both traits. Thus, *C. arcticum* differs from cultivated *C. xgrandiflorum* which is a short day plant. Analysis of the other morphological traits also demonstrated significant variation among populations. Future studies could examine how morphology of extant populations differs from our extensive collection of herbaria specimens to determine potential genetic bottlenecks in the species.

Specified Source(s) of Funding: Minnesota Agricultural Experiment Station

Identification of Two New Races of *Diplocarpon Rosae* wolf, the Casual Agent of Rose Black Spot Disease *(Poster Board #284)*

David Zlesak[1]; Darcy Ballantyne[2]; Matthew Holen[3]; Andrea Clark[2]; Kristen Smith[4]; Jason Zurn[5]; Nahla Bassil[6]; James M. Bradeen[3] and Stan C. Hokanson*[3], (1)University of Wisconsin, River Falls, (2)University of Minnesota - Dept. of Horticultural Science, (3)University of Minnesota, (4)Star Roses and Plants, (5)USDA-ARS NCGR, (6)USDA-ARS Corvallis

The fungal pathogen, *Diplocarpon rosae* Wolf, infects only roses (*Rosa* spp.) and leads to rose black spot disease. Rose black spot is the most problematic disease of outdoor grown roses worldwide due to the potential for rapid leaf yellowing and defoliation. Plants repeatedly defoliated from black spot become weakened and may eventually die from lack of energy reserves. Eleven races of the pathogen were previously characterized from isolates collected in North America and Europe. Isolates of *D. rosae* obtained from infected leaves of Brite Eyes™ ('RADbrite'; isolate BEP; collected in West Grove, PA) and Paprika™ ('CHEwmaytime'; isolate PAP; collected in Minneapolis, MN) proved to have unique infection patterns using the established host differential and Lemon Fizz™ ('KORlem'). The new races are designated race 12 (BEP) and 13 (PAP), respectively. A differential infection pattern on Lemon Fizz™ is what distinguished race 12 from the previously characterized race 7. Expanding the collection of *D. rosae* races provides an ever more valuable resource for ongoing efforts to identify and characterize unique race-specific resistance genes in *Rosa* and virulence genes in the pathogen as well as for supporting rose breeding programs.

Specified Source(s) of Funding: USDA-NIFA SCRI

The Impacts of Ploidy and Seasonal Development on Fruit Size and Sugar Concentrations on Berries in *Vaccinium Ovatum* *(Poster Board #285)*

Kristin E. Neill*, Oregon State University, Horticulture and Ryan N. Contreras, Oregon State University

There is growing interest in using native and edible plants in home landscapes. *Vaccinium ovatum,* evergreen huckleberry*,* is a native plant in the Pacific Northwest which has evergreen leaves and tart fruit. The native and evergreen qualities make this plant an ideal candidate for breeding for home landscapes. However, its poor form and small, tart fruit detracts from its aesthetics and use in gardens and of these traits, we are focusing on fruit qualities first. Little is known about the development of huckleberry fruit over the course of a season. Therefore, the purpose of this project was to investigate fruit size and sugar concentration over nine weeks to compare plants with different ploidy levels. Specifically, our objectives were to 1) assess the impact of ploidy level on fruit size and brix and 2) determine optimum harvest time. Tetraploids ($2n = 4x = 48$) and mixoploids ($2x+4x$) were developed in 2013 and ploidy was confirmed in 2018. This project assessed overall fruit size using a digital caliper, sugar concentration (Brix) using a digital refractometer, and seed germination percentage in 2017 and 2018. In 2017, there was only one harvest date where it was found that Brix was highest for mixoploids and lowest for diploids. Ploidy level had a positive relationship with fruit size in 2017. In 2018, fruit characteristics were measured over a nine-week period to determine optimal harvest time. Berry volume gradually increased finally plateauing after seven weeks, while Brix started decreasing immediately after sampling began. To allow fruit size to reach its maximum but maintain Brix at peak levels, our data suggests collecting at approximately 2723 Growing Degree Days (GDD). GDD were calculated by summation of all days with mean daily temperature above the base temperature of 10°C.Germination percentages increased following 3 weeks of cold stratification, suggesting this species has physiological dormancy.

Specified Source(s) of Funding: Dr. Ryan N. Contreras and Oregon State University

A New *Pavonia* Interspecific Hybrid with Ornamental Potential *(Poster Board #286)*

Yongjun Yue* and John M. Ruter, University of Georgia

The genus of *Pavonia* Cavanilles is usually found in tropical and subtropical areas and is likely the largest genus in the Malvaceae. The parents of the new interspecific hybrid are *P. lasiopetala* (maternal) and *P. missionum* (paternal). *Pavonia lasiopetala* is a small shrub with a woody base reaching around 1-1.2 m in height. It is native to Texas and northern Mexico and inhabits dry, rocky soils. Flowers are pink to rose-red (RHS 68A) and around 40 mm in diameter with a yellow staminal column. *Pavonia missionum* is a perennial shrub native to South America, specifically Brazil, Argentina, and Paraguay. Shrubs are 1-2 m tall with the same width. Flowers are orange-red (RHS 33A) in color with a yellow staminal column. The new hybrid carries unique traits and can potentially be used as a landscape plant. From 60 initial crosses made in Fall 2017, 83 seed were obtained and 26 germinated in 2018. Six of these seedlings showed novel traits while the remaining seedlings appeared identical to the maternal parent. The six hybrid seedlings are morphologically intermediate to both parents. Leaves are 2-6 cm long, slightly longer than wide with an acute apex, cordate leaf base, dentate to crenate margins, and an overall cordate leaf shape. Flowers are solitary and located in the leaf axis with 1-2.5 cm long pedicels and five lanceolate involucellar bracts with 7-9 × 2-2.5 mm in size. Flowers measure 35-45 mm in diameter with petioles 1.5-4 cm in length. Four of the new hybrids show red color flowers (RHS 46B) and the remaining two hybrids show red-purple color flower (RHS 57C). Since the new hybrid is an interspecific hybrid, it produces little to no pollen and no seed set was observed in 2018. Since the six interspecific seedlings appear to be sterile invasiveness should not be a problem and plants will be reproduced from vegetative cuttings. The performance of the six hybrids will be evaluated in 2019 for potential release as cultivars.

Preliminary Study of ISSR Markers Associated with Morphological Traits of *Hydrangea Macrophylla* Clones. *(Poster Board #287)*

Qian Song[1]; Donglin Zhang*[2] and Richa Bajaj[2], (1)Flower Research Institute of Guangxi Academy of Agricultural Sciences, (2)University of Georgia

Hydrangea macrophylla is a popular floricultural and garden plant and many new cultivars have been introduced to the market each year. To better figure out their genetic variation and molecular links to their morphological characteristics, we selected six ISSR primers from our 96-screened primers to investigate the association of molecular markers and morphological traits. Eighty bands were produced from these six primers and average bands per primer were about 14. Among them, fifty-four bands were polymorphic bands, which accounted for 67.5% of total bands. Hydrangea macrophylla 'Greenmentle' is a bud mutation from H. macrophylla 'Goliath' with greenish tepals. Among the 61 bands, there were 18 unique ISSR markers to distinguish greenish to pink or blue tepals, which indicated that the color changes of tepals should be detectable using ISSR markers. In term of inflorescence types, we observed 'Twist-N-Shout' had both mop-head and lace cap inflorescence on the same plant. ISSR markers revealed that this plant was identical with other regular 'Twist-N-Shout' Individuals. Double flowers (multiple layers of tepals) had significant different from ISSR markers when compared to single flowers. From 79 bands amplified for both single flowered 'Goliath' and double flowered 'Izu No Hana', only 32 shared bands. Golden leaved mutation had several distinguished bands compared to the green leaf cultivar. ISSR markers provide useful molecular information among the cultivars of bigleaf hydrangea, which can potentially lead to the link between morphological characteristics to their gene(s).

Specified Source(s) of Funding: Grants from University of Georgia Research Foundation and Georgia Seed Development Commission. Ms. Qian Song is currently a visiting scholar at the University of Georgia

SMRT Genome Sequencing in Gerbera and NB-LRR Genes in the Gerbera Genome *(Poster Board #288)*

Krishna Bhattarai*, Gulf Coast Research and Education Center, University of Florida and Zhanao Deng, University of Florida

Single Molecule Real-Time (SMRT) sequencing is a powerful technology that is rapidly changing the field of plant genomic and genetic research. Long sequencing reads produced by this technology have made it possible to overcome multiple inherent challenges that large, highly repetitive and complex genomes create for genome sequencing and *de novo* genome assembly and to examine gene structures and splice variants. Gerberas (*Gerbera xhybrida*) are one of the most popular flowers in the global floricultural trade for their bright and attractive flowers. They are grown mainly as cut flowers and also as flowering potted or garden plants. The large size (5.5 Gb) and heterozygous and highly repetitive nature of the gerbera genome make it difficult to conduct genomic research in this flower. In this study, we report the first use of PacBio SMRT sequencing in gerbera and identification of the nucleotide binding-site leucine-rich repeat (NB-LRR) class of disease resistance genes (*R*-genes), the most common *R*-genes in plants. The genomic DNA of a powdery mildew-resistant gerbera line was sequenced using the PacBio RSII platform and the P6-C4 chemistry to a depth of about 3x. Sequenced reads had an average N50 of 16.7 kb, a mean read length of 11,894 kb, and a mean read score of 0.84. NB-LRR genes in the gerbera genome were identified using the available homologous sequences from the sunflower and lettuce genomes.

Specified Source(s) of Funding: UF/IFAS Plant Breeding

Graduate Initiative; USDA-NIFA hatch project (FLA-GCC-005507)

Screening the National Boxwood Collection for Resistance to *Calonectria Pseudonaviculata* – Prospects for Resistant Germplasm *(Poster Board #289)*

Yonghong (Henry) Guo, USDA-ARS and Rutgers University; Matthew H. Kramer, USDA-ARS and Margaret Pooler*, USDA-ARS, U.S. National Arboretum

Boxwood *(Buxus* L. spp., Buxaceae) are popular woody landscape shrubs grown for their diverse forms and broad-leaved evergreen foliage. Each year, more than 11 million boxwood plants are sold in the United States, with an annual market value of $126 million. Boxwood plants grown in temperate zones are now threatened by a destructive blight disease caused by the ascomycete fungus *Calonectria pseudonaviculata*. The disease was first identified in the United Kingdom in 1994 and it has spread throughout continental Europe, parts of western Asia, New Zealand, and into North America. It causes dark brown to black lesions on leaves and severe defoliation leading to plant death in nurseries and established landscapes, hence the need to develop blight-tolerant boxwood cultivars. The National Boxwood Collection at the U.S. National Arboretum contains more than 700 *Buxus* accessions, making it one of the most complete collections in the world and a valuable genetic resource for developing blight-tolerant varieties. We screened all of these accessions using a lab-based detached leaf assay, and found variability in tolerance, but no complete resistance. We found that in some cases, our results were inconsistent with results of previous resistance screening assays, which were sometimes inconsistent with each other. We performed a meta-analysis using all data sets available producing a list of cultivars sorted by their resistance, along with a measure of resistance variability. In addition, we determined which kinds of assays were most reproducible. Results will enable further development of consistent and accurate resistance screening protocols and indicate the most suitable material for developing more resistant cultivars.

New Abelia Cultivar 'rosy Charm': A Heavily-Blooming Hybrid with Purple Flowers and Pink Sepals *(Poster Board #290)*

Carol D. Robacker*, University of Georgia, Georgia Campus and Michele Scheiber, Star Roses and Plants

An interspecific cross between the cultivar *A*. 'Edward Goucher' and *Abelia chinensis* was made in Griffin, Georgia in 1998. Eleven seedlings were obtained from this cross and were planted in Griffin in 1999. Two patented cultivars, 'Raspberry Profusion' and 'Lavender Mist' were selected from among these seedlings. A third seedling, to be named 'Rosy Charm' (originally labeled 99-6-7), was vegetatively propagated and evaluated with multiple replications in Griffin (cold hardiness zone 8a) since 2002 and in Blairsville GA (cold hardiness zone 7a) since 2003. 'Rosy Charm' has many outstanding qualities and is being released as a new cultivar. This plant has a spreading, upright growth habit. Flowers are purple and occur in compound panicles, mostly terminal, ranging from 18 to 30 cm long and 6 to 10 cm wide. The subpanicles are 7 to 9 cm long and 5 to 6 cm wide. The number of individual flowers per inflorescence is 250 to 750. Sepals are red-purple, or pink. The most distinctive quality of 'Rosy Charm' is the heavy and continuous display of pink/purple flowers and sepals from May through September. Average height and width of 12-year-old unpruned plants in Griffin was 256 cm and 279 cm, respectively. Laboratory freeze tests showed a mid-winter cold hardiness of -21 C. Late spring freezes frequently cause shoot tip burning or die-back on abelia cultivars in Griffin. 'Rosy Charm' rarely has any late spring freeze damage in Griffin, but minor damage has occurred some years on replicates in Blairsville.

Specified Source(s) of Funding: University of Georgia Research Foundation

Identification of Anthocyanidins in Anthurium Hybrids By High-Performance Liquid Chromatography *(Poster Board #291)*

Peter J. Toves*[1]; Emily S. Teng[2]; Jon-Paul Bingham[2] and Teresita D. Amore[3], (1)University of Hawaii, (2)University of Hawaii at Manoa, (3)University of Hawaiʻi at Mānoa

Anthurium is the most economically important cut flower in the Hawaiʻi floriculture industry. Major spathe colors in the market include red, orange, pink, white, and green Unique and rare purple colored anthuriums also exist. Spathe color is due largely to pigments known as anthocyanins. Anthocyanin profiling for anthurium has been done, but previous studies represented a few varieties. Anthurium hybrids were selected based on color and potential contribution to the cut flower breeding program. Anthocyanidins, the sugar free counterparts of anthocyanins, were selected for analysis because they are simpler to identify and quantify accurately with external standards. Flavonoid extraction methods from pitanga, *Eugenia uniflora* fruit (Wheeler, 2013), were adapted for the anthocyanidin extraction from anthurium spathes. Spathes were ground into fine powder (1 g) in liquid nitrogen then added to acidic methanol for extraction of anthocyanins, which were pre-purified to remove lypophyllic compounds, then hydrolyzed with acid to remove sugars. Hydrolyzed fractions were loaded into a Waters™ Alliance 2695 Separations Module with a Waters™ 996 Photodiode Array Detector and an XBridge™ Peptide XB-C18 column. HPLC chromatograms from sample fractions were compared to anthocyanidin standards: cyanidin, pelargonidin, delphinidin, and peonidin. Cyanidin was highest in pink spathes, pelargonidin was highest in orange spathes, and white spathes had the least amount of total anthocyanidins.

Specified Source(s) of Funding: USDA-NIFA Hatch 868

Postharvest 2 (Poster)

Seasonal Changes in Fatty Acids Linked to Needle Loss in Four Genotypes of Balsam Fir,*Abies Balsamea* l. *(Poster Board #387)*

Gaye MacDonald[1]; Rajasekaran R. Lada[*2]; Claude D Caldwell[3]; Chibuike Udenigwe[4] and Mason T. MacDonald[3], (1) Dalhousie University, Faculty of Agriculture, (2)Faculty of Agriculture, Dalhousie University, (3)Dalhousie University, (4)University of Ottawa

Several studies have suggested that postharvest needle retention in balsam fir increases in autumn due to cold acclimation, and that this is more evident in Christmas tree genotypes with lower postharvest needle abscission resistance (NAR). The objective of this study was to compare the fatty acid profiles of low needle abscission resistant genotypes to high needle abscission genotypes. In a 4 x 4 factorial experiment, four genotypes of balsam fir, clones 9, 37, 506 and 566, were sampled for fatty acids at five time periods, ranging from September, 2013 and February 2014. In addition, opposite branches on the stem were transferred to the lab, hydrated and monitored to determine mean needle abscission commencement (NAC) and peak needle abscission (PNA). Abscission commenced after 52, 42, 75, and 32 days in clones 9, 37, 506, and 566, respectively. Peak needle abscission occurred at a mean of 57, 50, 80, and 36 days, respectively. Clone 506 had significantly better needle retention than all other genotypes in each of the sampling periods ($p < 0.001$). All genotypes commenced needle abscission significantly earlier when collected in February than when collected in September through December ($p< 0.001$), possibly related to a January thaw. Fluorescence was significantly ($p< 0.05$) linked with photoperiod($R^2= 0.542$). Δ5-UPIFA composed > 20% of fatty acids in all clones, 5,9-18:2 (taxoleic), 5,9,12-18:3 (pinolenic), 5,9,12,15-18:4 (coniferonic), 5,11,14,17-20:4 (juniperonic), and 5,11,14-20:3. There were many significant interaction and main effects between date sampled and clone ($p< 0.05$).There was a significant decrease in 16:0 and 16:1 between September and February. There was a significant increase in unsaturated acids 18-2 cis (linoleic acid) and 5, 9, 12-18:3 (pinolenic acid). There was a significant increase in FA with a chain length greater than 20. There was a significant decrease in 5,9 -18:2 between October and November, and again between December and February unique to Clone 506, suggesting that it could be related to its superior ability to retain needles postharvest.

Specified Source(s) of Funding: Atlantic Innovation Fund, NSERC, Nova Scotia Department of Natural Resources, Dalhousie University

Comparative Fruit Performance and Major Metabolic Responses of Two Summer Apples during Cold Storage *(Poster Board #388)*

Seungyeon Han[1]; Hnin Phyu Lwin[1]; Soon-Il Kwon[2]; In-Kyu Kang[3]; Young-Je Cho[4] and Jinwook Lee[*5], (1)Chung-Ang University, Department of Integrative Plant Science, (2)National Institute of Horticultural and Herbal Science, Apple Research Institute, (3)Kyungpook National University, Department of Horticultural Science, (4)Kyungpook National University, School of Food Science and Biotechnology, (5) Chung-Ang University, Department of Plant Science and Technology

As extremely early season apples, ‘Summer King’ and ‘Summer Prince’ cultivars are harvested at the end of July and thus their popularity is increasing. The objective of this study was to evaluate the comparative responses of fruit quality attributes and major metabolites in these two summer apple cultivars stored at 1°C for up to 3 months. Fresh weight loss was higher but soluble solids content was lower in ‘Summer Prince’ than in ‘Summer King’ apples. Flesh firmness was relatively stable in ‘Summer Prince’ but decreased significantly in ‘Summer King’ apples during the second half of cold storage. Although hue angle gradually declined regardless of cultivar and tissue type, it was higher in ‘Summer King’ than in ‘Summer Prince’ apples during cold storage. While sucrose level was higher, fructose and sorbitol contents were lower in ‘Summer Prince’ than in ‘Summer King’. Three major organic acids were higher in ‘Summer King’ than in ‘Summer Prince’ apples. Aspartic acid, glutamic acid, arginine, alanine, GABA, tyrosine and leucine were higher in ‘Summer Prince’ than in ‘Summer King’ apples but serine, histidine, methionine, trytophane, phenylalanine, and isoleucine were lower during cold storage. Furthermore, the incidence of lenticel blotch was higher in ‘Summer Prince’, compared to ‘Summer King’ apples. Overall, the results indicated that physiological performance and metabolic alteration of these two summer apples differed during cold storage. Financial support for this research was provided by a grant through the 2018 Research Fund (PJ012455052019) of Rural Development Administration, Republic of Korea.

Specified Source(s) of Funding: Financial support for this research was provided by a grant through the 2018 Research Fund (PJ012455052019) of Rural Development Administration, Republic of Korea.

Genetics of Shelf-Life in Heirloom and Modern Populations of Strawberry Segregating for a Broad Spectrum of Fruit Quality Attributes *(Poster Board #389)*

Stefan Petrasch*; Randi Famula; Glenn S. Cole; Michael A. Hardigan; Barbara Blanco-Ulate and Steven J. Knapp, University of California, Davis

Over the last 80 years, genetic gains for increased fruit firmness, yield, shelf-life, and other attributes essential for

year-round production and long-distance shipping have been significant in strawberry. While heirloom cultivars produce low yields of highly perishable, short shelf-life fruit, modern cultivars produce high yields of long shelf-life fruit that can withstand the rigors of harvest, storage, and long-distance shipping. Genome-wide analyses of nucleotide diversity have uncovered selective sweeps and population stratifications that are strongly correlated with populations developed for different end-markets, shelf-life requirements, and production environments. Genetic mechanisms underlying these phenotypic differences are poorly understood and understudied. Here, we report on genome-wide association and genomic prediction studies geared towards identifying loci and developing insights into the genetics of fruit quality traits that either determine or are pleiotropically affected by genetic variation for shelf-life. We developed a training population of 400 half-sib individuals developed from crosses between an extremely high yielding, extra firm, long shelf-life cultivar (UCD9) and four highly perishable short shelf-life cultivars, two from western European and two from the southeastern US. These populations were genotyped with a 49,000 SNP array anchored to the octoploid reference genome and are currently being phenotyped for several fruit quality traits. We will report our initial findings, including GWAS results and the accuracy of genomic predictions for sugars, acids, firmness, and other important determinants of fruit quality in short and long shelf-life germplasm.

Developing a Variety Specific Starch Scale for WA38 Apple *(Poster Board #390)*

Felix Schuhmann; Marcella Galeni; Manoella Mendoza* and Ines Hanrahan, WA Tree Fruit Research Comm

WA38 is an apple variety developed by the Washington State University Apple Breeding Program as the result of a cross between 'Enterprise' and 'Honeycrisp'. This apple variety will be sold commercially for the first time in 2019. One of WA 38 unique characteristics is the starch degradation and starch pattern development during maturation of the fruit. Starch is one of the maturity parameters utilized by the Washington apple Industry as a method to determine optimum harvest timing. When iodine is applied to the apple core it binds with starch particles and develop a dark coloration patter. Overtime starch converts to sugar and the dark pattern will start to clear. The objective of this experiment was to develop a variety specific starch scale to aid assessment of WA38 maturity. The scale values will range from 1 to 6, with 0.5 increments. To achieve a surface reflecting the middle of the core, WA 38 apples were cut, unlike other industry specific varieties, right through the equator and the surface was scraped to have a clean pattern. During the experiment, two predominant patterns were observed. The commonly known "flower" pattern, which is characterized by 5 "flower petals" growing with advancing maturity. The other pattern was named "radial", and it can be compared with a "sunrise". The patterns appeared in a 6:4 ratio in 2017 and in a 3:7 ratio in 2018. Another observation was the slow disappearance of dark color and consequently starch once fruit was harvested and placed into storage. The experiment also showed that the starch patterns took longer to develop, compared to other industry specific varieties. WA38 starch readings are possible in less than 5 minutes, but depending on fruit temperature and maturity, the development of a complete starch staining took up to one hour. In most cases the pattern developed fully after 28-30 minutes if the fruit is warm (72°F), 50-60 minutes if the fruit came from cold storage. In comparison, Granny Smith apples took up to 10 minutes, when the fruit came from cold storage and 2.5 minutes, when the fruit was warm (72°F). Sometimes the starch pattern was not even, showing more maturity on one side of the cut. It was hypothesized that it could be related to sun exposure, as in general, apples show advanced maturity on the sun exposed side. However, for WA38 this hypothesis could not be validated.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

Effect of 1-Methylcyclopropene Treatment on Fruit Quality Attributes and Antioxidant Metabolism in Cold Stored 'Gamhong' Apples *(Poster Board #391)*

Jung-Geun Kwon*[1]; Jingi Yoo[1]; Nay Myo Win[1]; Ha-ram Jung[1]; Seon-Hyang Kim[1]; Dae Hyun Kim[1]; Jinwook Lee[2]; Soon-Il Kwon[3] and In-Kyu Kang[1], (1)Kyungpook National University, Department of Horticultural Science, (2)Chung-Ang University, Department of Plant Science and Technology, (3)National Institute of Horticultural and Herbal Science, Apple Research Institute

This study was carried out to evaluate the effect of 1-methylcyclopropene (1-MCP) treatment on fruit quality attributes and antioxidant metabolism in cold-stored 'Gamhong' apples. 1-MCP (1 $\mu L \cdot L^{-1}$) was applied for 18 hr after harvest and stored at 0°C for up to six months. Flesh firmness, titratable acidity (TA), and soluble solids content were higher in 1-MCP treated fruit than in control fruit during cold storage. The increase in weight loss was significantly delayed by 1-MCP treatment, compared with control. Internal ethylene concentration (IEC) and ethylene production were highly increased in untreated fruit, compared with 1-MCP treatment. Total phenolic content (TPC) and total flavonoid content (TFC) were higher in control fruit than 1-MCP treated fruit. Total anthocyanin content (TAC) was higher in control fruit than 1-MCP treated fruit at the end of storage. DPPH and ABTS radical scavenging activities were higher in control fruit than in 1-MCP treated fruit at the end of storage. The correlation responses were more significant in control than in 1-MCP treatment. Firmness was always positively correlated with TA, but negatively with weight loss, IEC, and ethylene production rate. TA was negatively correlated with TPC, TFC, and TAC. However, weight loss was positively done with TPC, TFC, and TAC. Overall, the results suggested that 1-MCP treatment should be highly necessary as postharvest treatment for apple storage. Nevertheless, the effectiveness of 1-MCP treatment on antioxidant activities was complicated during cold storage. Financial support for this research was supported by a grant from 2017 Research Fund (PJ01245502) of Rural Development Administration, Republic of Korea.

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Effect of 1-Methylcyclopropene Treatment on Phenotypic and Genetic Alterations of Fruit Quality in Cold-Stored Korean Apples *(Poster Board #392)*

Jingi Yoo*[1]; Jung-Geun Kwon[1]; Nay Myo Win[1]; Ha-ram Jung[1]; Seon-Hyang Kim[1]; Dae Hyun Kim[1]; Jinwook Lee[2]; Soon-Il Kwon[3] and In-Kyu Kang[1], (1)Kyungpook National University, Department of Horticultural Science, (2)Chung-Ang University, Department of Plant Science and Technology, (3)National Institute of Horticultural and Herbal Science, Apple Research Institute

The objective of this study was carried out to investigated the effects of 1-MCP treatment on phenotypic and genetic alterations of fruit quality in 'Fuji', 'Hwangok', and 'Picnic' apples during cold storage. 1-methylcyclopropene (1-MCP, 1 $\mu L \cdot L^{-1}$) was applied for 18 hr after harvest and then stored at 0℃ during six months. Flesh firmness and titratable acidity (TA) of 1-MCP treated fruit were higher than control fruit during storage progressed, while soluble solids content (SSC) and weight loss were not affected. Notably, the flesh firmness, TA and SSC of 'Hwangok' and 'Picnic' apples were higher than 'Fuji' apple. Internal ethylene concentration (IEC) and ethylene production were highly increased by control fruits, compared with 1-MCP treated fruits. Furthermore, IEC and ethylene production of 'Hwangok' and 'Picnic' apples were lower than 'Fuji' apple. Total sugar content was higher in 'Fuji' and 'Hwangok' apples by 1-MCP treatment compared with control, but not in 'Picnic' apple. In uronic acid content, 'Picnic' apple by 1-MCP treatment was higher than control, but not in 'Hwangok' and 'Fuji' apples. 1-MCP treatment delayed the increase of all cell wall hydrolase activities in 'Fuji' apple, compared with control. However, activities of β-glucose (β-Glc) and α-manosidase (α-Man) decreased in 'Hwangok' apple and its of β-galactosidase, α-galactosidase, β-Glc, α-Man, and β-xylosidase decreased in 'Picnic' apple by 1-MCP treatment. The expression of ethylene biosynthesis *ACO* and *ACS* genes was significantly higher in control fruit than in 1-MCP treatment in three apple cultivars. The expression of ethylene signaling *ETR* gene was also higher in control fruit than in 1-MCP treated fruit in 'Fuji' and 'Picnic' apples, except 'Hwangok' apple. Financial support for this research was supported by a grant from 2018 Research Fund (PJ01382702) of Rural Development Administration, Republic of Korea.

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Ripening Features Affected By Aqueous 1-Methylcyclopropene (1-MCP) Concentration in Mature Green 'Cavendish' Type Banana Fruit *(Poster Board #393)*

Lan-Yen Chang* and Jeffrey K. Brecht, University of Florida

For bananas held at or above the chilling threshold temperature, usually considered to be 13°C, ripening is the major shelf life limiting factor. However, extending banana shelf life at or near its chilling threshold by delaying ripening could shift the shelf life limitation to another factor, possibly chilling injury. Therefore, we considered treating green bananas with the ethylene action inhibitor, 1-methylcyclopropene (1-MCP), to test the hypothesis that delaying ripening at the chilling threshold temperature, thus allowing longer exposure to that temperature, would result in development of chilling injury. However, prior to testing that hypothesis, it was necessary to determine an appropriate 1-MCP concentration to delay ripening while still allowing eventual ripening recovery. Rather than using the typical 12- to 24-h gaseous 1-MCP treatment procedure, we used a 1-minute immersion in aqueous 1-MCP solution, which has been shown to exhibit similar efficacy (Choi and Huber, 2008). Freshly delivered mature green bananas were obtained through a local retail store and the hands were cut into individual fingers and randomized. Half the fruit were treated with 100 µL/L ethylene for 24 h at 20°C (+ETH) and the other half held in air at 20°C (-ETH). Bananas were immersed in 0, 10, 25, or 50 µg/L 1-MCP (a. i.) solution at 23°C for 60 s followed by air drying. Ripening features were evaluated every 1 or 2 d at 20°C based on the rate of ripening. The ripening of ethylene pre-treated green bananas was little affected by 1-MCP, but the ripening of control (no ethylene pre-treatment) fruit was significantly delayed. Control fruit immersed in 0, 10, 25, or 50 µg/L 1-MCP reached ripeness stage 7 (yellow with brown flecks) after 27, 29, 37, and 39 days, respectively, while ethylene-treated fruit required 11-15 days. Peak climacteric respiration for ethylene-treated fruit occurred on days 5-6, while for the control it was 15, 21, 30, 31 d for 0, 10, 25, 50 µg/L 1-MCP, respectively. Bananas ripened without ethylene, especially those with 1-MCP treatment, had less bright appearance corresponding to lower L and b* values than ethylene-treated fruit without 1-MCP. It is possible the carotenoid biosynthesis pathway in the peel was affected by the inhibition of ethylene action via 1-MCP. To conclude, the minimum effective 1-MCP concentration for a 1-min aqueous application to delay banana
ripening at 20°C was 25 µg/L, which resulted in a 10-d

An asterisk (*) in front of a name indicates the presenting author.

extension over the 0 μg/L 1-MCP/-ETH treatment.

Specified Source(s) of Funding: Taiwan Council of Agriculture

Incidence of an Herbaceous/Bitter Flavor That Affects Quality of Sweet Cherry (*Prunus avium* L. cv. Regina) during Fruit Maturation and Storage *(Poster Board #394)*

Carolina Contreras*[1]; Juan Pablo Zoffoli[1] and Anne Plotto[2], (1)Pontificia Universidad Católica de Chile, (2)USDA-ARS

Chile's sweet cherry production has grown by ~363% over the last two decades, and is currently mostly being exported to China. Shipping from Chile to China results in travel and commercialization periods up to 50 days. Among the top three cherry cultivars produced in Chile, 'Regina' (a German bred variety) is highly planted because it is a late season variety and it is resistant to cracking. However, a herbaceous/bitter taste has been reported to appear in 'Regina', both at harvest and during/after storage, affecting its fruit quality and commercialization. Therefore, the objective of this work was to study the development of the odd-flavor and to understand the associated sensory and quality aspects during fruit ripening and storage.'Regina' sweet cherries were harvested from an orchard with prior year high incidence of bitter taste. Six phenological stages were studied: pre-*véraison*, *véraison*, bright red, red (commercial harvest), dark red and black color (senescence). At commercial harvest, additional cherries from three different orchards from southern Chile were harvested and stored for 30 and 45 days at 0 °C, plus 3 days at 15 °C. Eighty sweet cherries were assessed for firmness, texture, soluble solid concentration, titratable acidity, color, ethylene production and respiration rate at each phenological stage and each storage date. Stem browning, and fruit internal browning and orange peel physiological disorders were also evaluated. Sensory evaluation was carried out with another eighty fruits to verify presence/absence of the odd-flavor taste. Cherries were halved, one half tasted by two panelists, and the other half liquid frozen and stored at -80 °C for further analysis. The herbaceous flavor was only present at the bright red and commercial harvest stages; no odd-flavor was found at the senescent stage. During storage, two out of three orchards presented herbaceous flavor at harvest and after 30 and 45 days of storage. Incidence was ~8-6% at harvest and remained constant throughout storage. Unlike the herbaceous flavor, bitter taste appeared only after 30 and 45 days of storage at 0 °C plus 3 days at 15 °C, and it showed independently from the herbaceous flavor. Interestingly, when fruit had internal browning incidence, neither herbaceous nor bitter flavor were present in the fruit. These preliminary results showed that the herbaceous flavor is a critical problem for 'Regina' storage. Quality and physiological relationships with the herbaceous flavor will be discussed.

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Managing Postharvest Storage Issues in a Problematic Mandarin Variety *(Poster Board #395)*

David Obenland, USDA-ARS and Mary Lu Arpaia*, University of California

Some mandarins have characteristics that make it more difficult to successfully store and market them if commercially treated in a conventional manner. In this study a proprietary mandarin variety known to be particularly sensitive to off-flavor development was subjected to a variety of alternative processing methods after harvest to determine if it was possible to improve the postharvest fruit quality in this and other varieties with similar storage problems. In an initial test fruit were washed and sanitized on a commercial packing line and a storage wax (SW, 1% solids) applied. The next day fruit were run over a research packing line and either SW or no wax (NW) applied followed by 3 or 7 weeks of cold storage at 5 °C. After cold storage fruit were again run over a packing line and either SW or pack wax (PW) applied, and the fruit further stored for 1 week at either 5 °C or 20 °C to simulate a marketing period. The nature of the coating prior to cold storage had no impact on fruit quality, whereas fruit coated with SW (1% solids) after initial cold storage had the highest fruit quality, primarily due to there being less off-flavor development. This was particularly true if the fruit were held at 20 °C. Temperature during the marketing period had the greatest overall impact on fruit quality, with fruit maintained at 5 °C having better flavor and lesser levels of decay and water loss, regardless of coating type. In a final test the above experimental format was again utilized except the NW treatment prior to cold storage was deleted and coatings after cold storage consisting of SW containing either 5, 10 or 15% solids. Evaluation after the marketing period indicated that there were no differences in fruit quality due to the variation in solids content in the SW coatings applied after cold storage. As has been noted in our prior work, this study indicated that it is very advantageous to maintain mandarins prone to off-flavor development at low temperatures, such as 5 °C, throughout storage and marketing to preserve flavor quality. If this is not feasible then the use of final coatings more permeable to gas exchange, such as the SW (1% solids) applied in this study, would be beneficial as long as excessive weight loss does not become an issue.

Novel Nondestructive Technique to Determine Optimum Harvesting Stage of 'Ataúlfo' Mango Fruit *(Poster Board #396)*

Jorge A. Osuna-Garcia*, INIFAP-Santiago Ixcuintla Experimental Station; Jesús Daniel Olivares-Figueroa, Universidad Autónoma de Nayarit; Peter M.A. Toivonen, Pacific Agri-Food Research Centre; Samuel Salazar-Garcia, INIFAP and Ricardo Goenaga, USDA-ARS

Mango fruit must be harvested at the right maturity stage to ensure good flavor and quality when ripe. Lately, a portable nondestructive device that uses near infrared spectroscopy to estimate fruit maturity is available. 'Ataúlfo' mango has a light-green skin at harvest, turning yellow-orange when ready to eat. The objectives of this assay were to validate a portable spectrometer on determining optimum harvesting stage of 'Ataúlfo' fruit using dry matter (DM) and skin color as reference values. To build the model, samples were collected on May 9, 2018, from an orchard located in Nayarit State, Mexico. Two hundred fruit were harvested at different ripening stages: 1. Unripe; 2. Green Mature 1 (GM1); 3. Green Mature 2 (GM2); 4. Green Mature 3 (GM3); and 5. Fully mature. Fruit were scanned with the F-750 (Felix Instrument Inc.) at three temperatures (15, 25, and 35 °C). Skin color ('a' value) was also measured at the three temperatures with a Minolta 400 Chroma meter. DM was attained in a conventional oven by drying samples for 72 h at 60 °C. We did two validations from a commercial packinghouse with six different lots of 35 fruit each on May 31 and June 18, 2018. In addition, during June 2018, we did a third validation comparing the F-750 versus the Heat Units Accumulation (HUA) technique with 'Ataúlfo' fruit harvested at 1,600 HU in Nayarit and Sinaloa States. The best model linearity was obtained on skin color 'a' ($R^2 = 0.98$) whereas for DM the R^2 was only 0.70. For the first validation, the best predicted value was skin color 'a' with an $R^2 = 0.9144$, followed by DM with an $R^2 = 0.7056$. On the second validation run, the adjusted predicted value for skin color 'a' had an $R^2 = 0.8798$, while DM had an $R^2 = 0.4445$. When comparing F-750 versus HUA in Nayarit, 'Ataúlfo' skin color ranged from -14.26 (dark green) to -6.61 (light green) while the skin color average difference between the F-750 vs the Minolta colorimeter was only -0.04. Alternatively, for 'Ataúlfo' harvested in Sinaloa, skin color ranged from -12.67 to -5.68. In this case, the skin color average difference between the F-750 vs the Minolta colorimeter was only -0.06, but the correlation was higher ($R^2 = 0.90$). In conclusion, using skin color with the F-750 may be a good nondestructive technique to determine the optimum harvesting stage on 'Ataúlfo' mango.

Application of Workflow Designed to Leverage Transcriptome Data for Enhanced Gene Expression Analysis in Tree Fruits *(Poster Board #397)*

Heidi Hargarten*, USDA, ARS, Tree Fruit Research Laboratory; Elena Kahn, USDA-ARS Tree Fruit Research Laboratory; Rebecca Schmidt, USDA-ARS and Loren A. Honaas, Tree Fruit Research Laboratory, USDA-ARS

Complex changes in gene expression occur during postharvest storage of tree fruits and often precede or accompany changes in ripening and disorder development. Targeted gene expression analysis fundamentally relies upon prior knowledge of the targeted gene. In an effort to improve this prior knowledge, we developed a workflow that leverages transcriptome data to discover cultivar-specific gene sequences and then guide primer design for quantitative real-time polymerase chain reaction (qPCR). We find that potentially problematic polymorphisms occur frequently in genes of interest when candidate primer binding sites were selected using a mismatched reference genome. These polymorphisms can be accounted for when utilizing transcriptome data from the target cultivar. We applied our work flow to another tree fruit, *Pyrus communis,* for qPCR validation of RNA-seq data generated from 'D'Anjou', but analyzed using the 'Bartlett' reference genome.

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Evaluation of Plant-Base Oil Formulations to Reduce Superficial Scald on Pears *(Poster Board #398)*

Carolina Torres*, Washington State University, TFREC and Gloria Sepulveda, Universidad de Talca

Superficial scald (SS) is an important postharvest physiological disorder on pears (Pyrus communis L.), more so today with the ban of diphenylamine (DPA) and ethoxyquin residues on fruit in European markets, leaving the industry with few (or none) control treatment options. The symptoms include irregular brown patches on the skin that can darken and sunken in severe cases. In order to find a replacement for synthetic antioxidants, a search for a new natural product started in 2012, a combination of plant-extracted oils and emulsifiers were evaluated on Packham's Triumph pears. Fruit quality (external appearance, firmness, soluble solids, ethylene production) and SS incidence during cold storage (up to 210 days, -0.5°C, >90% RH) were assessed under laboratory and semi-commercial conditions. After the first 3 years, we selected 4 prototypes based on their level of phytotoxicity on the fruit as well as efficacy. In the next 3 years we also included dose-response experiments. Final formulations at 1% (v/v) drenched at harvest have shown efficacy levels >80%, and significantly ($P \leq 0.05$) greener and firmer fruit throughout the storage period compare to the untreated control and DPA-treated fruit.

Physicochemical Properties of Selected Blackberries Cultivated in Alabama *(Poster Board #399)*

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Blackberry is becoming the fourth most important berry after strawberry, blueberry, and red raspberry. This fruit has been always a favorite native fruit in the Southern states of U.S. Thirteen Arkansas released blackberry selections including established cultivars (*Rubus* sp.) including APF 27, APF 41, APF 46 (primocane cultivars), APF 46, A1937, A2195, A2215, A2241, A2315, Chickasaw, Kiowa, Navaho, Ouachita, and Prima Jan (floricane cultivars), were selected to evaluate for physicochemical properties. These cultivars which have originated from the interbreeding of genetically heterogeneous variable species, have superior disease

An asterisk (*) in front of a name indicates the presenting author.

resistance, fruit production and quality. pH ranged from 3.35 to 3.68. Titratable acids (TA) and total soluble solids (TSS) varied between 4.20 to 8.88 (%) and 3.88 to 6.44 (%) respectively. Total soluble solids/titratable acids ratio was calculated (TSS/TA) as maturity index (MI). The highest MI was measured in APF 46 with the value of 1.55. The lowest value of MI was also measured in Prima Jan cultivar (0.47). Cultivar selection plays a crucial role in fruit production, consumer demand, food and nutrition security, and subsequently in human health. Results of this study will assist producers in selecting the best varieties in order to satisfy consumer's preferences.

Free Sugars, Dietary Fiber Profiles and Functionality of Fresh or Preserved Yuzu *(Citrus junos)*

(Poster Board #400)

Seung-Hee Nam*, Chonnam National University

Free Sugars, Dietary Fiber Profiles and Functionality of Fresh or Preserved Yuzu *(Citrus junos)*

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Yuzu is mostly consumed as traditional Korean herbal tea, preserved yuzu which is made from sliced yuzu peel and combined with sugar prepared as fruit preserves or marmalade. Yuzu is effective in preventing certain diseases owing to its anti-inflammatory, antioxidant, and anti-cancer function. In this study, we compared free sugar content, dietary fiber profiles, and phenolic contents of the fresh and preserved yuzu to find out the nutritional or functional changes by preservation. Here, preserved yuzu is produced by addition of 40% sugar (w/w) and keep at 4°C for 6 months. Preserved yuzu contained 5~18 times higher free sugar than fresh yuzu. Fructose was 2 times higher than glucose or sucrose at fresh yuzu but not in preserved yuzu due to sucrose added for storage. For dietary fiber profiles of fresh and preserved yuzu pulp, preserved yuzu contained a fifth of dietary fiber content (7.3%) compared to that of fresh yuzu (38.2%). Interestingly, 70% of yuzu dietary fiber was transferred from pulp part to juice during sugar preservation. Dietary fiber composition was studied to measure cellulose, hemicellulose, pectin, and lignin contents. Preserved pulp had more soluble fibers like pectin or hemicellulose, instead of insoluble fiber like lignin. Fresh yuzu pulp composed of mostly pectin and lignin, meanwhile, preserved pulp had mainly hemicellulose and pectin. For functional properties, ABTS and DPPH radical scavenging activities were higher at fresh yuzu (49 µM vit C eq.) than preserved yuzu (9.1 µM vit C eq.). Total phenolic contents was 4 times higher at fresh yuzu, compared to preserved yuzu but flavonoids content (hesperinidin and naringin) by HPLC analysis was 3 times higher at preserved yuzu than fresh yuzu. Those results indicated that preserved yuzu could be a potential nutritional food source with higher soluble dietary fibers and flavonoids contents in food industry.±<u>**This study was financially supported by Rural Development Administration (Project No. PJ013826).**</u>

Keywords: Fresh yuzu, preserved yuzu, dietary fibers, antioxidant activity

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Viticulture and Small Fruits 3 (Poster)

Chilling Requirements for 'Edelweiss', 'Frontenac' and 'Norton' Grapevines *(Poster Board #333)*

Benjamin A. Loseke and Paul E. Read*, University of Nebraska

The chilling requirement necessary for many cold-hardy grape cultivars is poorly understood. The objective of this study was to determine the number of chilling hours necessary for 'Edelweiss', 'Frontenac' and 'Norton' grapevines to reach 50% budburst. Grapevine budburst typically advances as the number of chilling hours accumulates. Generally speaking, the environments where these grape cultivars are grown are not limited by the lack of chilling hours, nevertheless, this information is still useful in understanding the release of bud dormancy. Canes from the three cultivars were collected from a research vineyard near Nebraska City, NE at two week intervals from November to April in 2016/2017 and 2017/2018. The canes were divided into single bud cuttings and bud position was noted – basal, medial and distal. The single bud cuttings were placed in forcing solution (200 mg/l 8-hydroxyquinoline citrate (8-HQC) and 2% sucrose) and buds were inspected bi-daily for budburst. When budburst occurred the Julian date was recorded and the cutting was removed from the experiment. The number of chilling hours differed between the two experiment years. 'Edelweiss' required 594 chilling hours to reach 50% budburst in '16/'17 but only need 381 hours in '17/'18. 'Norton' was more similar in the two years requiring 450 hours the first year and 381 hours the second year. The variability of chilling requirements from year to year can be influenced by the rate of dormancy onset and accumulation of chilling hours but requires further research to understand the relationship between these factors.

Specified Source(s) of Funding: Nebraska Agricultural Experiment Station with funding from Hatch Act through the USDA National Institute of Food and Agriculture

High Tunnel Table Grapes: An Alternative to Field Production in Nebraska? *(Poster Board #334)*

Paul E. Read*; Stephen J. Gamet and Benjamin A. Loseke, University of Nebraska

Commercial field production of table grapes in Nebraska vineyards has been attempted, but although production is feasible, quality issues have prevented wide adoption. Because the grape berries often are damaged by various environmental factors, considerable labor expense to remove damaged berries and thus provide marketable clusters has made field production unprofitable. We therefore established a project to attempt to produce a quality product by growing table grapes under protection in a high tunnel. Five cultivars are being tested to determine suitability for production in a high tunnel constructed on the University of Nebraska Horticulture Garden area in Lincoln, Nebraska. Cultivars included 'Canadice', 'Marquis', 'Mars', 'Somerset Seedless' and 'Thomcord'. Bare root plants were planted in the spring of 2017 in rows oriented north/south employing a bilateral high cordon trellis system, with the planting consisting of three 5-plant replications in a completely randomized block design. Cluster removal was practiced to prevent fruiting with the goal of harvest measurements to be taken in the 2019 growing season; bud burst, fruit set and vine growth data will be presented. Growth measurements were recorded in the first two growing seasons with results indicating significant differences among the cultivars as follows: 'Thomcord' > 'Somerset Seedless' = 'Mars' > 'Marquis' > 'Canadice'. The exceptional vigor of 'Thomcord' was surprising, since it had not been tested in our previous research and was considered to be suspect in terms of hardiness, suggesting that further monitoring will be required. Temperatures inside the high tunnel versus the ambient outside environment have been monitored throughout the duration of the project; temperature management and modification is achieved via adjustable side-vents. This project, if successful, will provide Nebraska growers with an alternative to wine grape production, possibly filling an early season high-value niche market.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant

Performance of Rootstocks in a Cabernet Sauvignon Vineyard Infested with *Xiphinema Index* and *Mesocriconema Xenoplax* Nematodes *(Poster Board #335)*

Rhonda J. Smith*, Univ of Calif Coop Extension and M. Andrew Walker, University of California Davis

A rootstock trial was planted in the Alexander Valley in Sonoma County, CA in 2012, one year after the previous vineyard was removed due to yield loss caused by grapevine fanleaf virus (GFLV). Dagger nematode, *Xiphinema index*, and ring nematode, *Mesocriconema xenoplax*, were present in the previous vineyard. The trial site remained fallow for one year and the trellis system was left in place; no pre- or post-plant nematicide applications were made. Vine spacing is 2.1 x 3.0 m (vine by row). Eleven rootstock treatments were planted as green benchgrafts in a randomized complete block design with eight replications of five vine plots. The rootstocks evaluated were GRN1, GRN2, GRN3, GRN4, GRN5 and O39-16, which are resistant to *X. index* and RS-3, RS-9, Schwarzmann, 1616C and 1103P, which have medium or low resistance. Vines were trained to bi-lateral cordons and spur pruned. Pruning weights increased for nearly all rootstocks over four years (2015 to 2018) with a significant treatment by year interaction. In 2018, vines on O39-16 and GRN2 tended to have the greatest pruning weights with 4.15 and 3.46 kg/vine respectively and vines on GRN1 had the least growth of the GRN rootstocks (1.88 kg/vine). Pruning weights of RS-9, RS-3 and 1616C were 9%, 13% and 23% of those of O39-16 respectively. In 2018, vines on GRN2, GRN3 and O36-16 had the greatest yields ranging from 12.2 to 13.9 kg/vine and RS-9 and RS-3 had the lowest with 3.6 and 4.5 kg/vine respectively. Nematodes were sampled by plot in December 2018: *X. index* was counted in eight and *M. xenoplax* counted in 25 of the 48 plots for the five GRN rootstocks and O39-16. *Xiphinema index* was counted in 25 and *M. xenoplax* counted in 24 of the 40 plots of RS-3, RS-9, Schwarzmann, 1616C and 1103P. In 2017, shoot tips were sampled from each vine, and composite samples analyzed by plot for GFLV by ELISA. At least 75% of all plots of Schwarzman, 1103P and 1616C tested GFLV-positive and 38% of all plots of RS-3 and RS-9 tested positive. Combined, 45% of the GRN plots tested GFLV-positive; GRN1 had one infected plot and the remaining GRN rootstocks each had three or more. In 2018, 60% of the GRN plots tested GFLV-positive. No O39-16 plots tested positive in either year. GRN rootstocks have maintained growth and yields under GFLV pressure.

Assessing Spatial Variability in Wine Flavonoid Composition Based on Vineyard Plant Water Status Mapping *(Poster Board #336)*

Runze Yu[1]; Luca Brillante[1]; Johann Martinez-Luscher[1]; Luis Sanchez[2] and Kaan Kurtural*[3], (1)University of California Davis, (2)E & J Gallo Winery, (3)University of California

Vineyard variability is present due to the variable physical environments, and it is limiting the berry and wine chemical composition and hence wine quality from being uniform and optimal. Ecophysical variability affecting grape and wine flavonoid composition was characterized in a Cabernet Sauvignon (*Vitis vinefera* L.) vineyard in Sonoma County, California for two consecutive seasons. Based on calculated stem water potential (Ψstem) integrals, the research site was separated into two distinct zones: severely (Zone 1) and moderately (Zone 2) stressed zones. Berry primary metabolites, including total soluble solids (TSS), titratable acidity (TA), pH, berry weights were measured throughout the whole season. Also, secondary metabolites of final wine

An asterisk (*) in front of a name indicates the presenting author.

were characterized with reversed-phase HPLC. TSS separated between the two zones in the first week of September in both years. When Zone 2 reached 26 °Brix in 2016 and 24 °Brix in 2017, Zone 1 reached 30 °Brix and 27 °Brix respectively, fruits were harvested and vinified separately. All anthocyanin and flavonol derivatives were higher in Zone 2 in 2016. Proanthocyanidin subunits were also higher in Zone 2 in 2016. However, there was no difference in any flavonoid compound in 2017. In 2017, the harvest was about 2 weeks earlier than 2016, the differences in flavonoid concentration was not affected greatly enough by Ψstem even though TSS was separated. Water stress exacerbated the anthocyanin degradation when harvesting relatively later in 2016. This study provides fundamental knowledge to coalesce vineyard variability in wine flavonoid composition based on plant water status by conducting differential harvest at an earlier time.**Keywords: grapevine, anthocyanins, flavonoids, water stress, spatial variability, viticulture, wine**

Rooting Characteristics of Cuttings in 'Shine Muscat' and 'Kyoho' Grape By Twig Size, Cutting Type and Time, and Temperature *(Poster Board #337)*

Su Jin Kim*; Sung Min Jung; Hyunil Kim; Dong Jun Im; Youn Young Hur; Dong Hoon Lee and Seo Jun Park, National Institute of Horticultural and Herbal Science

Rooting characteristics of cuttings in 'Shine Muscat' and 'Kyoho' grape by twig size, cutting type and time, and temperature were investigated to figure out the optimum cutting conditions. The optimum diameter of twig for rooting was about 11mm in both grape cultivars. The No. of root, root length and rooting rate were higher at node-cut cutting method than at internode-cut cutting method (conventional method) in both grape cultivars. As the cutting time was delayed until 4 April compared to mid-March and end-March, the rooting rate, No. of root, and length of root increased at both grape cultivars. The rate of rooting was higher at the 25°C cutting bed than at the 30 and 35°C cutting bed in both grape cultivars. The xylem of 'Shine Muscat' twig had about two times amount sucrose and fructose than in those of 'Kyoho' twig. However, the rate of rooting was higher in 'Kyoho' (about 82%) than in 'Shine Muscat' (about 63%) grape cuttings at the same conditions. Therefore, soluble sugar and mineral contents of twig was not related for rooting in our study. To understand the differences in rooting between the 'Shine Muscat' and 'Kyoho' cultivars, the other factors such as starch and hormones have to be investigated.

Consumer Horticulture and Master Gardeners (Poster)

Tomato Root Pruning Affects Plant Dry Weights but Not Yields *(Poster Board #031)*

Marisa Yvonne Thompson*; Stephanie J. Walker; Charles D Havlik and Dawn VanLeeuwen, New Mexico State University

Tomatoes are the gateway vegetable for home gardeners nationwide. Accordingly, tomato-related problems are among the most common questions received from the public based on a survey of County Extension agents with the New Mexico State University (NMSU) Cooperative Extension Service. Tomato planting recommendations tend to be anecdotal and widely varied for root-bound, store-bought plants intended for urban gardens. The effects of root pruning on tomato vigor and yield have not been previously reported in New Mexico. This 2018 study used a completely randomized design to explore the effects of four transplanting methods on two tomato hybrid cultivars, 'Bella Rosa' (determinate) and 'Big Beef' (indeterminate). Tomatoes were planted from seed and grown in 1-gal containers until substantially root-bound before transplanting into prepared planting beds at the NMSU Agricultural Science Center at Los Lunas. To emulate backyard growing conditions, tomato plants were spaced at 0.61 m between plants within a row and 1.52 m between rows, then caged for support. Each combination of treatment and variety was assigned randomly to four experimental units containing four plants within the same row. Data was collected from only the two inner plants. Rows were flood-irrigated approximately once per week from June through Sept. At the time of planting, root-bound plants were subjected to one of four treatments of varying root pruning intensity: (1) POP N DROP, control treatment where plants were un-potted and set directly with minimal root disturbance; (2) LIGHTLY SCUFFED, where outer surface of root ball was firmly chafed; (3) HALVED, where half of the root ball was severed completely on the diagonal; and (4) WASHED, where the entire root ball was submerged in water and washed free of soil. Dependent variables included above-ground and below ground tissue dry weights, stem caliper, and tomato yield. Yield was recorded as red tomato weights harvested when ripe and green weights of tomatoes harvested at the end of the season, just before the first frost. No differences in total tomato yield were detected between cultivars or treatments, despite extreme differences in root pruning technique at the time of planting. Significant cultivar differences were detected in dry weights and stem caliper, with 'Big Beef' consistently higher than 'Bella Rosa.' Significant treatment differences were also detected for dry weights, with the less disturbing POP N DROP and LIGHTLY SCUFFED treatments tending to have larger sizes compared to the two more extreme root pruning treatments, HALVED and WASHED.

Pollinators for Food: Planting Pollinator Attractive Annuals Alongside Self-Pollinated Peppers to Improve Harvest *(Poster Board #032)*

Julie Weisenhorn*; Annie Klodd; Vincent A. Fritz; Gary Oehlert and Mary Hockenberry Meyer, University of Minnesota

Previous work on the attractiveness of annual flowers to pollinators promoted the question about how this information could be used to improve crop yields. In this study, we asked the question “Would self or wind pollinated crops produce better if pollinator-attractive flowers are planted nearby?” Ace peppers were the chosen crop because they are primarily pollinated by wind, relatively easy to grow and have minimal pest issues. Literature reviews found out that large bees (bumble, honey) were the primary insect pollinators on peppers. I selected three annual flowers in my previous study that were shown to attract honey, bumble and other native bees on some level and demonstrated continuous bloom: Showstar butter daisy, Double Click cosmos, and Orange Fudge Rudbeckia. Twelve of each variety were together as a single planting adjacent to 36 Ace bell peppers. The 18 peppers closest to the flowers were open to pollinators while the other 18 peppers were covered with exclusion fabric that prevent insect pollination. Crops were planted at three sites: the Minnesota Landscape Arboretum (Chaska MN), the University of Minnesota North Central Research and Outreach Center (Grand Rapids, MN) and the Ottertail County fairgrounds (Perham, MN). A half-sized planting was established in a raise bed in the Horticulture Display Garden (St. Paul campus) as a demonstration site for Gopher Adventures youth day camp. Complete data was only obtained and reported from Grand Rapids and the Arboretum site. Peppers were harvested when they started to ripen – a visual indication they had reached their mature size. The fruit was counted, measured and weighed to determine an average fruit weight for that harvest. Being that seed development is an indicator of good pollination, seeds were extracted from harvested fruit and weighed and an average seed count per fruit was obtained. Data for the excluded plants at Grand Rapids and the Arboretum were combined, and data for the open plants (open to pollination) for these two sites were combined. The results demonstrate pollinator interaction improves bell pepper harvest. This information supports the value of planting pollinator-attractive flowers near / adjacent to wind-pollinated or self-fertile crops.

Specified Source(s) of Funding: Horst Rechelbacher Foundation

Comparison of Utility Lights for Starting Lettuce Transplants *(Poster Board #033)*

James W. Shrefler*, Oklahoma Cooperative Extension

Home gardeners often lack a suitable location for starting vegetable transplants. This can limit opportunities to use cultivars not readily available as transplants or to use season extension techniques if planting materials are not available when needed. One option is to sow seed in containers kept indoors if a location with suitable exposure to sunlight is available. However, in the absence of adequate lighting poor results are received when plants are grown indoors. Plant quality begins to decline at seedling emergence due to seedlings becoming etiolated and spindly. Further seedling development may be weak and plants may develop additional abnormalities. Various widely available and economical lighting products that can easily be supported over plants could be used to start garden seedlings if suitable plant growth can be obtained. Several types of lights available as units measuring approximately 40 in. by 6 in., including fluorescent and light emitting diode (LED) technologies were evaluated for starting vegetable plants using several varieties of garden lettuce *Lactuca sativa L.* as a test species. Following seeding, lights were installed over trays throughout the germination process and during two weeks of plant growth. Lettuce plants developing under either a “Active Spaces Daylight” fluorescent (D) or an LED “Shop Light” (S) were shorter and had a deeper green color than those developing under a fluorescent “Plant and Aquarium” (P) light. Photosynthetically active radiation (micro mol m^{-2} s^{-1}) produced by the three lights at 2 cm from the sources were 71, 35 and 15, for sources S, D and P, respectively. The ratios of red to far red light were determined for the sources using a sensor designated for 660 and 730 nm. Ratios for S, D, and P, were 1.6, 1.5 and 0.75, respectively. Possibilities for using these lights for starting plants in a home environment will be discussed.

Specified Source(s) of Funding: Oklahoma Cooperative Extension Service

Growing Online: Using Blogs to Distribute and Promote Extension Horticulture Publications

(Poster Board #034)

Caroline Warwick[1]; Angela Colonna[*2] and Roger Kjelgren[1], (1)University of Florida, (2)UF/IFAS Mid-Florida Research and Education Center

Blogs have become one of the most popular ways to share information on digital channels as social media has become key to reach target audiences. Blogs often cater to specific demographics with simple, to-the-point text to gather information about a desired topic, like gardening or cooking. Blog articles often contain about 350-500 words and act as an informational resource for online audiences. As higher education faculty cope with administrative desire for greater public outreach, the ability to communicate and share information is valued more now than ever. To help lighten the load of increased outreach expectations for faculty members, the University of Florida Institute of Food and Agricultural Sciences Mid-Florida Research and Education Center (MREC) used blogs as a tool to distribute and promote new Extension horticulture publications. MREC staffers wrote blog articles about research updates on horticultural practices, pests and plants in the form of an Electronic Data Information Source (EDIS) publication. This blog article was then promoted on MREC’s Facebook, Twitter and Instagram accounts to drive readers to the EDIS website to download this free Extension document. From January 2018 to December 2018, MREC found the impact of blogs to be quite significant on EDIS download numbers.

Over the 12-month period, a blog article was posted to the MREC blog and promoted on social media every month for a total of 12 EDIS publications. Of the EDIS publications highlighted, the number of downloads ranged from at least 400 to over 1200 for each document. On average, 724 EDIS downloads occurred as a result of each blog post. Using blogs to promote Extension horticulture publications is shown to be an effective way to distribute information about integrated pest management practices, including pest and disease identification, weed management and smart practices, as well as other horticulture-related topics. The reach of each blog was amplified by the use of social media channels. Given the shift in demographics that use social media and to engage with younger generations, the continued use of blogs and social media is important to expand the scope of ages who access this information and to disseminate pertinent horticulture research.

Grafted Tomato Field Trials to Inform Non-Commercial Grower Decisions *(Poster Board #035)*

Natalie Bumgarner*, University of Tennessee

Grafting for vegetable crops has been in use for decades and much research has been conducted in the United States to ascertain potential benefits for commercial producers. The emphasis has been well placed on field vegetable production and the potential for grafting to address disease issues, increase yield, and lower risk in these commercial operations. Interestingly, as the research has progressed to determine management needs and cost-benefit models, there has been concurrent marketing to non-commercial audiences. Many of the same potential benefits of grafting exist for gardeners and other non-commercial growers, but economic hurdles to adoption can be lower for these small-scale growers. There are many avenues for benefit in the use of grafted tomatoes for gardeners, including overcoming disease limitations in relatively fixed garden sites, reduction of management time, and the opportunity to reduce plant number due to yield increases. However, field research directed to non-commercial audiences has been less investigated. Further elucidation as to which tomato cultivars and settings would be most impactful for gardeners to incorporate grafting would support the highest return on investment in the use of grafted plants. This project was designed to address the use of grafted tomatoes in non-commercial settings by using cultivars and management methods applicable to this audience. Three years of trials were conducted in Knoxville, Tennessee, using representative indeterminate and determinate tomato cultivars. One grafted rootstock (‘Emperador’) was used with several scions in comparison to ungrafted scion plants. ‘Big Beef’, was grown in all three years, and five comparison hybrid and heirloom cultivars were used to ascertain potential benefits for determinate and indeterminate cultivars. In the trial site without known history of soil borne disease issues, results showed there was a potential for yield increases in both hybrid and heirloom indeterminate tomato cultivars. This presentation will include an overview of trial results and discuss potential beneficial areas of grafted plant use for non-commercial growers.

Planting Density and Fertilizer Placement Effects on Giant Marconi Peppers Grown in Sub-Irrigated Containers *(Poster Board #036)*

Gary R. Bachman*; Christine E. H. Coker; Patricia R Knight; Jenny B. Ryals and Corey Wheeler, Mississippi State University Coastal Research and Extension Center

Concerns of fresh produce sources and safety continue to drive the increased interest in establishing home vegetable gardens. This is especially true in urban situations where the perception that a large garden spot is needed and only small spaces are available. Sub-irrigated containers offer a successful gardening system for gardeners with limited space such as small yards, porches, or even balconies to grow vegetables.The goal of this project was to grow at three planting densities and two fertilizer placements the 2001 All-America Selections winner Giant Marconi pepper (*Capsicum annuum* “Giant Marconi”) in sub-irrigated containers. The commercially available sub-irrigated EarthBox (EB) was the system used. Following the home owner instructions, each EB received pre-plant dolomitic lime (2 cups) mixed into the container mix (Sunshine #8). Fertilizer treatments consisted of 10-10-10 (1 cup) applied in a band either longitudinally or transversely across the top of the container mix each EB. Giant Marconi pepper plugs (Knox Nursery, Apopka, FL) were grown out in 4-inch cups for one month and transplanted into the sub-irrigated containers on May 26, 2018. Planting density treatments were 2, 4, or 6 transplants per sub-irrigated container. Fruit were harvested approximately every 14 days beginning on June 27, 2019 and ending on November 8, 2018. Data collected included the total number of fruit harvested (both usable and culls), fruit weight by planting density and fertilizer placement. Planting density of 2 and 4 plants per EarthBox had similar harvest results and both were significantly greater than the 6 plants per EarthBox. Longitudinal fertilizer placement, regardless of planting density, resulted in significant greater fruit harvested compared to transverse fertilizer placement for all measurable data except culls. Information on potential harvest from vegetables grown in sub-irrigated containers like an EarthBox is valuable for the home gardener with limited growing space to meet family needs.

Plant Database Redesign *(Poster Board #037)*

Lucy K. Bradley*, North Carolina State University

NC State Extension granted $104,000 to the NC Extension Gardener program to transform the plant database (http://plants.ces.ncsu.edu) into a world-class resource. Based on evaluation of plant databases around the world; surveys of Extension agents, Extension Master Gardener volunteers and plant database users; and focus groups, we created an innovative tool for gardeners, Extension Master Gardener volunteers, extension staff, landscape professionals, university staff, and students. We now captures three times more data points per plant record, have high resolution photos that document seasons, life cycles, plant parts as well as plant use in the landscape, and have improved search capability. The database has three main pathways: Find the Right Plant; Identify a Plant; Browse the Gallery. We have added IPM information as well as recommendations for alternate plants, with fewer pest problems, that can fill the same function in the landscape. In addition, we provide links to plants that are frequently confused with the plant being viewed. While the funding covered software, staff, and IT support to create the expanded structure of the database, it would not have been possible to populate the new fields, upload the thousands of photographs, and update the existing records without the invaluable support of Extension Master Gardener volunteers.

Genetics & Germplasm 3 (Poster)

Single Nucleotide Polymorphisms (SNPs) Based Fingerprinting of the Texas A&M Potato Breeding Collection *(Poster Board #230)*

J. Pandey*[1]; D. C. Scheuring[1]; J. W. Koym[2]; A. Chappell[1]; J. C. Miller Jr.[1]; J. Coombs[3]; D.S. Douches[3] and M. I. Vales[1], (1)Texas A&M University, (2)Texas A&M AgriLife Research and Extension Center, (3)Michigan State University

The Texas A&M Potato Breeding Program focuses on the development of early maturing varieties for different market classes such as processing chippers, fresh market russets, specialties, and reds adapted to Texas growing regions. Proper identity preservation (genotypic and phenotypic) and maintenance of released varieties and advanced clones/selections in tissue culture is fundamental to having sources of disease-free stocks to be used as parents and for seed multiplication. Genetic contamination or admixing between clones can occur in any program handling large amounts of plant material for extended periods of time. Initial phenotypic observations of greenhouse-propagated clones suggested that some misidentifications in the *in vitro* germplasm collection have likely occurred in the past 30–40 years of *in vitro* maintenance and regeneration. Further, little is known regarding the genetic diversity of this working potato breeding collection. Ninety-six clones from the program were genotyped using the Infinium 22K V3 Potato Array to develop DNA fingerprints. Tetraploid and diploid potatoes representing different market classes were included in the present study. Hierarchical clustering, based on 13,907 polymorphic SNP loci, was performed using the R package 'ape.' Accessions generally clustered together based on market class and ploidy level, with some deviations. The highest percent heterozygosity was observed in Atlantic (60%), followed by TX12484-2W (52%). The heterozygosity of diploids was much lower than tetraploids. Overall, the Infinium 22K V3 Potato Array was successfully used to genotype clones and determine unique fingerprints for clones included in the Texas A&M potato breeding collection.

Specified Source(s) of Funding: USDA-NIFA

DNA Barcoding of the Solanaceae Family in Puerto Rico Including Endangered and Endemic Species *(Poster Board #231)*

Dimuth Siritunga*, University of Puerto Rico and Lumariz Hernandez, University of Puerto Rico Mayaguez

The Solanaceae family is one of the major groups of angiosperms, with more than 2,000 species and approximately 100 genera. This family contains species with agricultural and economical importance worldwide such as potatoes, eggplants, tomatoes and peppers. In Puerto Rico we have approximately 46 species of Solanaceae including eggplants (*solanum melongena*), peppers (*Capsicum sp*.) and six endemics: *Brunfelsia densifolia, Brunfelsia lactea, Brunfelsia portoricensis, Goetzea elegans, Solanum ensifolium* and *Solanum woodburyi*. The endemic species are threatened and endangered in the wild due to reduction in their habitat caused by land loss. Therefore, our objective is to prove if DNA Barcoding can be used as a rapid and easy way to identify these species and assess the relationship between Solanaceae species in Puerto Rico. To accomplish our objectives, two chloroplastic and a nuclear region called DNA barcodes were amplified: psbA-trnH, Matk and ITS respectively. A total of 76% of the Puerto Rico Solanaceae had been analyzed. We have found that the pairwise distance range was 0.000-0.017, 0.000-0.054, and 0.007-0.088 for *matK, psbA-trnH* and *ITS* respectively. The outgroup pairwise distance range was 0.166-0.296, 0.350-0.670, and 0.172-0.467 for matK, psbA-trnH and ITS, respectively. In all three markers, the genus that showed the highest pairwise distance between its species was *Solanum* genus, while the genus that display the least was *Capsicum* with 0.000. Phylogenetic trees of concatenated sequences were generated from species of this study and from NCBI database to identify species. This technique can be used to identify species with two or three combinations of barcodes depending on the species. Also, this is the first study to include the endemic *Solanum woodburyi* in a molecular analysis and was found to have a close relationship with *Solanum ensifolium* and *Solanum bahamense*. Overall, DNA barcoding can be used to identify Solanacea effectively with exception of the *Capsicum* genera.

Specified Source(s) of Funding: USDA-Hispanic Serving Institition program

Identification of Single Nucleotide Polymorphism Markers for DNA Barcoding in Cultivated Tomato (*Solanum lycopersicum*) *(Poster Board #232)*

Minkyung Kim, Sejong Unversity and Sung-Chur Sim*, Sejong University

Single nucleotide polymorphisms (SNPs) have been commonly used as molecular markers in crop species due to high-throughput genotyping methods. The present study was conducted to identify a core set of SNP markers for identification of commercial tomato cultivars. We collected 48 F_1 cultivars representing four market classes (freshmarket, cherry, grape and rootstock) from 14 private breeding programs. Genotyping by sequencing for this collection generated a total of 90,469 SNPs across 12 chromosomes. Of these, 14,400 SNP were selected based on minor allele frequency (> 5%), missing data rate (< 10%) and minimum depth (5x). These SNPs were further filtered with the polymorphism information content (PIC) values of ≥ 0.3 and genome distribution to identify a core set of 400 SNPs. To validate these core SNPs, a subset of 192 SNPs was used to genotype additional 72 F_1 cultivars (29 freshmarket, 23 cherry, 17 grape and three rootstock) using the Fluidigm dynamic arrays. We found that 152 SNPs (79.16%) showed distinct polymorphisms in the 72 cultivars and these markers were able to differentiate 116 of 120 cultivars (96.67%) using a hierarchical clustering method. Furthermore, a model-based clustering analysis detected four sub-populations in this tomato collection. The 41 of 44 freshmarket cultivars were divided into two subpopulations and seven rootstock cultivars were grouped into one of these subpopulations. The 33 cherry and 36 grape cultivars were not separated into two distinct subpopulations. This sub-population structure was supported by pairwise estimates of F_{st}. These results suggest that our core set of SNP markers can be a useful resource to develop an effective DNA barcode system for cultivar identification and seed purity test in tomato.

Evaluating F2 of a Genetic Cross between Salt-Sensitive and Salt-Tolerant of Tomato for Potential to Enhance Salinity Tolerance and Fruit Quality *(Poster Board #233)*

Dhuha Mohamed*, purdue university

Salinity stress is becoming more acute problem as the cultivated land are becoming more saline by the residual salt left after underground water irrigation. We have previously developed genetic cross between a salt-sensitive cultivar of *Solanum lycopersicum* CA4-S and a salt-tolerant wild relative (WR) *Solanum pimpinellifolium* LA1606-T and characterized progenies of F1 hybrids for salt tolerance (Ezin *et al*., 2018, Agricultural Sciences 9, 1553). This characterization resulted in several F1 lines exhibiting higher salt tolerance or salt sensitivity compared to parental lines. The objective of present investigation was to determine potential of developing salt tolerant tomato genotypes by evaluating response of selected putative salt tolerant and sensitive F2 progenies to salt treatment. One-month-old seedlings from several putative tolerant and sensitive F2 progenies were cultivated in the presence of continuous 185 mM NaCl and their salinity tolerance was evaluated by quantifying several growth and development parameters. These parameters include plant height, SPAD values as indicator of chlorophyll levels, days to flowering, fruit set and ripening. The plant height was significantly retarded (over 50 %) for the salt sensitive F2 progenies whereas the salt tolerant F2 progenies exhibited only 20 % reduction. We are presently quantifying changes in fruit lycopene levels. We are also conducting transcriptome analyses to determine the effect of salt treatment on differential gene expression in fruit to delineate the role of saline conditions on fruit quality.

Development of Snps in Melon (cu*cumis melo l.*) Varieties Using Genotyping By Sequencing *(Poster Board #234)*

SangMin Chung*, Dongguk University

Forty eight melon varieties were subjected for developing SNPs using genotype by sequencing (GBS). The SNP loci with missing data more than four genotypes were removed from total 8076 SNP loci detected from the GBS analyses. Subsequently, 5644 SNP loci were chosen and the average of polymorphism information contents (PIC) was 0.2. Two hundred seventy SNP loci with the highest PIC values were retained and their genotypes were used to conduct UPGMA tree for genetic relationships of 48 melon varieties using PAUP software. To distinguish closely related varieties, newly screened SNP loci were added and the SNP loci with similar genotypes were removed from 270 SNP loci. In conclusion, 192 SNP loci with high PIC values (0.373) were chosen for classification of melon varieties

Genome-Wide SNP Discovery and Genetic Diversity Analysis in Cultivated Pumpkin (*Cucurbita* spp.) *(Poster Board #235)*

Nam N. Nguyen and Sung-Chur Sim*, Sejong University

Pumpkin (*Cucurbita* spp.) is a major vegetable and three species (*C. moschata*, *C. maxima*, and *C. pepo*) are commonly cultivated worldwide. To identify genome-wide single nucleotide polymorphisms (SNPs), we collected 48 commercial F_1 pumpkin cultivars consisting of 18 *C. moschata*, 15 *C. maxima*, 7 *C. pepo*, and 8 interspecific hybrids (*C. moschata* x *C. maxima*). Genotyping by sequencing found a total of 202,722 SNPs across 20 chromosomes. These SNPs were pre-filtered with three selection criteria: minor allele frequency of > 5%, missing data rate of < 10%, and minimum depth of 5X. The resulting 37,869 SNPs were further filtered to develop a core set of 400 SNPs based on the polymorphism information content values of ≥ 0.3 and genome distribution. Of these core SNPs, 192 SNPs were used to genotype additional 188 accessions (94 F_1 cultivars, 50 breeding lines, 44 landraces) for validation. One hundred and seventy SNPs (88.54%) showed polymorphisms in these accessions. With the 170 SNPs, genetic variations were assessed between and within the predefined groups of 223 cultivated pumpkin accessions. Principal component analysis and hierarchical clustering found four sub-populations representing three pumpkin species and interspecific hybrids. These genetic differentiations were supported by pairwise estimates of F_{st}. The sub-population consisting of interspecific hybrids showed a higher level of genetic diversity relative to the other three sub-populations. Furthermore, 206 of 223 accessions (all 85 breeding lines and landraces and 121 of 138 F_1 cultivars) were distinguished using the 170 SNP markers. The SNPs identified in this study will be a useful resource to develop breeder's tools for cultivar identification, seed purity test, and marker-assisted selection in pumpkin.

Variation in Nutrient Contents and Retention in Fresh-Cut Lettuce *(Poster Board #236)*

Jinita Sthapit Kandel*; Beiquan Mou; Ivan Simko and Ryan J. Hayes, USDA-ARS

Fresh-cut lettuce is widely used in packaged leafy vegetable salads. Most fresh-cut products involve harvesting whole mature heads of romaine or iceberg lettuce, cutting leaves to a specified size, and packing in modified atmosphere packaging (MAP). Despite MAP, fresh-cut lettuce has short shelf life and loss of nutrient content. Lettuce cultivars exhibited genetic variation for shelf life in MAP, but genetic variation for nutrient retention is not known. The objectives of this research were to determine if there is genetic variation among cultivars for retention of different nutrients and to determine the relationship between shelf life and nutrient retention. Fifty accessions were selected based on previously observed differences in shelf life and lettuce type. Accessions were planted in randomized complete block design in a field in Salinas, CA, with three replications. Mature lettuce heads were harvested, processed, and stored at 4°C. Vitamin C (ascorbic acid) was analyzed 1, 2 and 3 weeks after processing (WAP), vitamin A (carotenoids) and sugars (glucose, fructose) were evaluated at 1 and 3 WAP. Stored samples were visually evaluated for shelf-life using a 0 to 10 scale, where the rating corresponds to $1/10^{th}$ of the estimated percentage of deteriorated tissue. Variation in nutrient content among the accessions was observed 1 WAP. *Lactuca serriola* (wild species closely related to cultivated lettuce), UC96US23, had highest content of vitamin C and A and lowest content of sugars at the initial evaluations. Iceberg lettuce, 'Salinas' and 'Salinas88', had lowest content of vitamins, and romaine lettuce, 'Triple Threat', had highest content of sugars. Three WAP, different levels of tissue deterioration were observed among the accessions. Romaine cultivars Romanor and Balady Cairo had the slowest and the fastest rate of deterioration, respectively. There was a positive correlation between tissue deterioration and degradation of all nutrients with the Pearson correlation coefficients (r) of 0.69 for ascorbic acid, 0.51 for glucose, 0.46 for fructose, 0.44 for total sugar, and 0.18 for total beta carotene degradation. Variation was observed in nutrient retention among accessions within slow deterioration and fast deterioration groups, which indicates an independent genetic component responsible for nutrient retention. 'Romanor', 'Salinas88', 'Darkland', and 'Green Forest' are some of the accessions with good shelf life and high retention of all evaluated nutrients. Identification of material with extended shelf life and high nutrient retention in this study provides valuable information for the fresh-cut salad industry and has implications for other types of fresh-cut salads.

Specified Source(s) of Funding: CDFA (California Department of Food and Agriculture)

Assessing Commercial Cultivar Potential in Sweet Potato (U'ala) Derived from Hawaiian Germplasm Using Phenotypic Data *(Poster Board #237)*

Todd W Anderson*; Michael Kantar; Theodore J.K. Radovich and Jon-Paul Bingham, University of Hawaii at Manoa

Sweet Potatoes have been an important staple in the Hawaiian islands and throughout the Pacific for centuries. The plants ability to be stored, high nutritional value, reliability to yield in drought or poor soil and versatility is the reason for this. The importance of sweet potato eclipsed taro in some dry leeward areas of Hawaii. Like all of the canoe crops, a plethora of varieties of U'ala were developed and maintained by the Hawaiians. These cultivars are genetically distinct from the newer varieties now commercially grown in the state, which are descended primarily from Japanese germplasm. The traditional varieties have been displaced throughout the state because of their growth habits, maturation time, pest resistance and yield are not easily adapted to commercial production.

Sweet Potato growers, like all farmers in the state are facing increasing pressure from high production costs. These include land prices, labor and import competition from the mainland. Imports of Asian type and orange flesh type sweet potatoes have forced local growers to leave the industry, switch to higher value shorter rotation crops or to concentrate on added value products from sweet potatoes, especially chips. Processing the crop requires infrastructure which is simply inaccessible for small growers, preventing them from being able to produce sweet potatoes economically. Varieties developed from Hawaiian traditional cultivars could be marketed as "Hawaiian Heritage" or similar designation so growers could earn a higher price point without processing. Value added products such as alcohol and desserts

The main purpose of this project is to identify traits in open pollinated crosses of Mohihi that was planted with eleven other varieties of traditional Hawaiian u'ala. This is called a polycross block, common with establishing breeding populations of sweet potatoes. Sexual reproduction in plants allows traits in the progeny to be expressed that are not visible in the parent plants. This is how we will use the crosses to identify traits such as yield, sugar content and basic traits and appearance of tubers. These traits will be used, along with a collaboration in trialing for potential alcohol production to establish the potential for further breeding work. It is hoped cultivar development utilizing traditional hawaiian crops will help farmers, create new marketing opportunities and allow the general population to access traditional Hawaiian foods currently unavailable.

Specified Source(s) of Funding: University of Hawaii at Manoa

Understanding Complex Horticultural-Quality Traits in Broccoli By Integrating Next-Gen Sequencing and Large-Scale Phenomics *(Poster Board #238)*

Zachary J. Stansell and Thomas Björkman*, Cornell University

Quality in horticultural crops is often the result of many subjective characteristics working together harmoniously. Improving quality through marker-assisted selection would therefore seem unlikely to work. Here we report an approach that can do so. While Next-Gen sequencing is affordable, these complex trait analyses are limited by the challenge of integrating and analyzing large dataset of descriptive information (phenomics): much software is designed to process only small numbers of molecular markers, analytic pipelines can only analyze a few traits, and different data sets are difficult to combine. Several techniques address these challenges. We evaluated 36 horticultural-quality traits in a large (N=175) mapping population generated from a cross of Chinese kale and broccoli. Phenomic data were captured with tools developed from the *One Handheld Per Breeder Initiative* and aggregated in a database. We developed a pipeline to generate high quality and density genome wide markers using genotype-by-sequencing across new accurate reference genomes. To interpret these high-dimensional datasets, we modified R/qtl2 mapping software to determine QTL confidence intervals and assign likelihoods to 290 putative genes for quality-related phenotypes. Combinations of these traits were associated with overall quality, and sometimes linked genetically. These can be used for marker-assisted selection. A similar approach can be used to improve the composition of secondary metabolites, morphology, and environmental stress response.

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Herbs, Spices, & Medicinal Plants (Poster)

Comparison of Organic Fertilizers to Produce Ginger (*Zingiber officionale*) in Pots *(Poster Board #071)*

Sharon Motomura*[1]; Kylie Tavares[2]; Joshua Silva[2] and Jensen Uyeda[2], (1)University of Hawaii, College of Tropical Agriculture and Human Resources, (2)University of Hawaii at Manoa

In Hawaiʻi, the primary limiting factor for the commercial production of ginger (*Zingiber officionale*) is the soil-borne disease known as bacterial wilt (caused by *Ralstonia solanacearum*) which has led to up to 60% of crop loss. Growing ginger in pots kept off the ground, using soil-less media, can prevent plants from becoming diseased. However, there is a higher cost of production as compared growing ginger in the field, because of this, producers are marketing their ginger as a source of seed. Organically produced seed can demand a higher price in the market. Preliminary results comparing fertilizer treatments including turkey manure and bone meal to a conventional slow release fertilizer were examined and found to produce comparable yields of ginger when grown in pots using peat moss and pearlite as media and planting disease tested ginger seed.

Yield and Quality of Turmeric and Related Germplasm on Maui *(Poster Board #072)*

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Turmeric and its relatives (*Curcuma* spp.) are grown for their rhizomes and consumed worldwide as food, spice, preservative, and coloring agent. Turmeric is also valued in Ayurvedic, Chinese, Hawaiian and other medical traditions to treat numerous illnesses, due in part to the antimicrobial, anti-inflammatory, and anticarcinogenic properties of curcuminoids. The turmeric industry has been rapidly expanding in Hawaii in response to increased demand at the local, national and international level. Field trials across the state are being conducted to assess marketable yield, curcuminoid concentrations, and suitability for various market outlets. One such field trial was conducted on the island of Maui at the University of Hawaiʼi Cooperative Extension's fields in Kula Agricultural Park. This germplasm evaluation was arranged in a randomized complete block design with four replications and included one accession each of *C. aromatica*, *C. caesia*, *C. mangga,* as well as five varieties of *C. longa:* 'Olena', 'BKK', 'Mystic', 'Joy', and 'Hawaiian Red'. Five plants per replicate were planted in May 2018 and were were harvested in February 2019. Fresh weights were taken at harvest for both marketable rhizomes and mother corms, which are used as seed. While there were not significant differences among the rhizome yields of *C. longa* varieties, the rhizome yield of Hawaii's industry standard 'Hawaiian Red' was numerically 37.5% greater than 'BKK', a variety previously identified as having very high (9%) curcumin content. *C. aromatica* and *C. mangga* yielded significantly more rhizomes than the *C. longa* varieties and *C. caesia*. *Curcuma mangga* (Mango Ginger) in particular has potential as a new crop in Hawaii due to is heavy yields and high palatability in value added products such as pickles.

Specified Source(s) of Funding: Maui County Office of Economic Development, Hawaii Department of Agriculture

Size and Spacing Influence Turmeric Production

(Poster Board #073)

Thomas W. Zimmerman*, University of the Virgin Islands

Turmeric (*Curcuma longa*) is a minor spice in the West, but has gained popularity as a supplement due to the anti-inflammatory and anti-cancer properties. Preliminary studies indicate that turmeric has tolerance to high pH calcareous soils not found in its cousin, ginger. Due to the lack of seed, turmeric is grown from seed rhizome pieces. The purpose of this research was to develop production systems for turmeric in the US Virgin Islands. Three rhizome seed sizes: single-node (60-90g), double-node (100-130g) and triple-node (140-170g) were planted at 6", 12" and 18" to determine efficiency of the planting density on rhizome production and size. Results indicated that rhizome seed size was the significant factor influencing turmeric production per plant basis. In-row spacing of 6" and 12" were not significantly different on a per plant basis for the 60-130g rhizome seed piece. However, on a per 100 ft row basis the 6" spacing produces significantly more rhizomes than either the 12" or 18" spacing. A trend indicated that larger seed pieces and in-row distance resulted in thicker rhizomes.

Specified Source(s) of Funding: This research was funded by USDA-NIFA Hatch and USDA-SCBG administered by the VIDoA.

Herbal Yield and Quality of Sage Plants Grown Under Hydroponic Conditions *(Poster Board #074)*

Marcus Nagle*, Central State University

Herbs are a usual crop grown in hydroponic systems. However, little is documented about the effect of this type of cultivation on the quantity and quality of the materials produced, in comparison to traditional soil mediums. Sage (*Salvia officinalis*) is a popular culinary herb which also has claimed medicinal properties. The objective of the presented study was to test the performance of hydroponically-grown sage plants versus soil-grown specimens in the same environmental conditions. Test subjects were cultivated for 25 weeks in a greenhouse in 10 cm pots with potting medium as control and in 10 cm cups in a hydroponic tube setup as the experimental treatment. Three individuals were planted in each pot/cup. Environmental conditions were identical and fertilizers were applied consistently for both treatments. Yield was measured at harvest per pot/cup with a total of 24 replicates from each treatment. Essential oils were extracted from bulk samples by hydrodistillation and analyzed for quantity and quality. The hydroponic treatment yielded significantly more aerial biomass than the soil treatment. Per dry basis, the amount of essential oil was not affected by treatment. In a similar respect, the composition of active constituents in the essential oils did not significantly differ between treatments. The study showed that hydroponically-grown sage performed well under this type of cultivation and the quality of active ingredients in the herb was not compromised.

Specified Source(s) of Funding: USDA-NIFA

Developing Best Management Practices for *Salvia Miltiorrhiza* Production in Mississippi *(Poster Board #075)*

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There has been a rapid increase in the use of medicinal herb plants for alternative and complimentary medicines to prevent and treat diseases including cancers in the United States. Currently, the majority of medicinal plants used in the US are imported from foreign countries. However, increasing concerns over safety such as heavy metal and chemical contaminations and lack of standardization and quality control pose significant challenges to US pharmaceutical and related industries in sourcing quality plant materials in the volume needed to meet the market demand. The objective of this study was to investigate the potential of growing medicinal plants in Mississippi and develop best production practices for selected medicinal plants. *Salvia miltiorrhiza* was used as a model plant in this study. *Salvia miltiorrhiza* is a traditional Chinese herbal medicines and has been widely used to treat cardiovascular diseases. In this study, a series of experiments were conducted to investigate seed propagation methods and nutrient management practices. Detailed results on germination performance, plant growth, and production of bioactive compounds will be presented.

Research Help Develop Tea, *Camellia sinensis* into a New Specialty Crop *(Poster Board #076)*

Yan Chen*[1]; Kathryn Fontenot[2]; Jeff Beasley[3]; Jeff Kuehny[3] and Jason W. Stagg[4], (1)Louisiana State University Agriculture Center & Research Station, (2)LSU AgCenter, (3) Louisiana State University, (4)Louisiana State University Agricultural Center

Tea plant, *Camellia sinensis* is an evergreen shrub adapted to the climate and acidic soils in Louisiana and many areas in the southeast. Production of tea as a commercial crop had been trialed in the history when there were shortages of tea supply but had never been further developed due to the intensive labor requirement in harvesting and processing tea. In recent years, however, there has been an increased interest in growing tea locally when the cost of labor in traditional tea production countries increased tremendously. This has made the price of locally grown tea, such as those from HI tea farmers, more competitive with the imported tea. In addition, the supporting local economy and local produce movement has made the timing perfect for local farmers to grow tea. A LSU AgCenter research project has looked at production and processing technologies for growing tea in Louisiana. An overview of the current commercial tea production in the U.S. and preliminary results from this research project will be shared with readers. An interview with a tea grower from Amite La will add in the perspective of new growers in terms of challenges and opportunities.

Specified Source(s) of Funding: Louisiana State Department of Agriculture and Forestry

Phytochemical Characterization of Native Hops (*Humulus lupulus neomexicanus*) *(Poster Board #077)*

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Three main groups of phytochemicals of value in hop (*Humulus lupulus*) cones: bittering acids and essential oils are of great interest to the brewing industry, and polyphenols (particularly xanthohumol) are of interest as a nutraceutical. The majority of commercial hops dominating the brewing industry originate from European plant varieties and thrive in a specific geographic location between 45-50° north latitude. *H. lupulus neomexicanus* is found at lower latitudes native to the Southwest Rocky Mountain region of the United States and is receiving recent attention with the rise of unique craft beer flavors and interest in nutraceuticals. Standard analysis of bittering acids and essential oils in *H. lupulus neomexicanus* hop varieties using American Society of Brewing Chemists (ASBC) methods revealed a wide range of bittering acid concentrations, but also consistently distinct essential oil profiles when compared to industry standard varieties. Presence of terpenes, rarely found in standard commercial hops, were abundant in *H. lupulus neomexicanus* varieties. While the essential oil profiles exhibited the presence of unique compounds, the total oil yield was less than 0.2 mL in all neomexicanus varieties due to hermaphroditic properties. Although the ASBC has released early research into hop polyphenols, they have not published a standard method for the extraction and characterization of polyphenols from hops. After comparing multiple published methods, an optimal ethanol extraction procedure was chosen that consistently yielded the highest total phenolic content (TPC) in extracts from standard and *neomexicanus* hops samples. *H. lupulus neomexicanus* extracts were consistently higher in total phenolic content (50-100mgGAE/g hops) than published literature values for standard hop varieties (2-50 mgGAE/g hops). Since xanthohumol is the most abundant phenolic compound in hops, a high TPC indicates the potential value of *neomexicanus* varieties as rich sources of xanthohumol. Because New Mexico is an agricultural state, identifying the potential of native and specialty crops grown in this region could help sustain agriculture in a multitude of downstream markets. The combination of the unique essential oils and high polyphenol concentrations create a potential niche market for *Humulus lupulus neomexicanus* production in the state of New Mexico, positioning the state to take advantage of expanding intrigue in this rarely used hops.

Specified Source(s) of Funding: New Mexico Department of Agriculture

Physiochemical and Functional Properties of Three Yuzu Varieties, Native, Namhae, and Tadanishiki *(Poster Board #078)*

Seung-Hee Nam*[1]; Hana Jeong[1]; Ha Kyeong Yoon[1]; Bo-Bae Lee[2]; Hye-sung Cho[2] and Youn-sup Cho[2], (1)Chonnam National University, (2)Jeollanam-do Agricultural Research and Extension Services

Yuzu (*Citrus junos* Tanaka), a sour fruit, is cultivated mainly in Japan and Korea. Yuzu is industrially used in the production of sweets, beverages, cosmetics, perfumery, and aromatherapy. Recently, various domestic yuzu varieties were developed for their higher contents of bioactive components like hesperidin, naringin, or stronger antioxidant property. The aim of study was to evaluate physiochemical and functional characteristics of three domestic yuzu varieties including native, Namhae, and Tadanishiki with respect to physical properties, total phenolics, antioxidant activity and anti-hypertension. Furthermore, functional flavonoids like hesperidin and naringin were detected by HPLC analysis. Compared to Native yuzu, Tadanishiki yuzu without seeds showed 40% harder and 30% more acidity but 50% lower fruit weight. Namhae yuzu showed similar physical pattern with native yuzu and highest fruit yields among three varieties. For functional characterization, Tadanishiki exhibited 129% or 132% higher amounts of total phenolics (380 mg) and flavonoid (5710 mg) than those of native or Namhae, based on 100g dried weight. By DPPH and ABTS radical scavenging activity, Tadanishiki detected the highest antioxidant activity with 79% ABTS or 33% DPPH scavenging activity compared to others. As the result of C18 reverse-phase HPLC analysis, hesperidin and naringin contents in Tadanishiki yuzu (261.0 mg and 96.9 mg per 100g) were 67% or 33.6% higher than those of native yuzu (156.9 mg and 72.5 mg per 100g). The angiotensin converting enzyme inhibition was 30%~ 40% higher at Tadanishiki yuzu than native or Namhae. Overall, those results indicate that Tadanishiki yuzu exhibited better physiochemical and functional properties than native or Namhea yuzu, suggesting as potential functional food agent. ±<u>This study was financially supported by Rural Development Administration (Project No. PJ013826).</u>

Keywords: Unripen yuzu, ripen yuzu, physiochemical properties, hesperidin

Specified Source(s) of Funding: * This study was financially supported by Rural Development Administration (Project No. PJ013826)

Catechins Quantification By HPLC of Five Green Tea Cultivars and Their Anti-Obesity Effects

(Poster Board #079)

Seung-Hee Nam*; Ha Kyeong Yoon; Hana Jeong; Kwang-Yeol Yang and Jong-Bang Eun, Chonnam National University

Green tea has been utilized in Oriental countries as well as Europe and United States due to its highly potential health benefits. Recently, green tea has received increased attention since people are aware of personal health and environment. Green tea is a very rich source of polyphenols and the major phenolic compounds are catechins like catechin (C), epicatechin (EC), epicatechin gallate (ECG), epigallocatechin (EGC) and epigallocatechin gallate (EGCG). Besides the contribution of catechins to tea taste, important pharmacological properties have been associated to their consumption, including antioxidant, anticancer, anti-inflammatory, anti-hypercholesterolemic activity, and especially anti-obesity effect. In this study, five green tea cultivars (Chamnok and Bohyang, Yabu, Hushun, and native) were evaluated their catechin profiles by C18 reverse-phase HPLC analysis and anti-obesity effect through α-glucosidase and HMG-CoA enzyme inhibition. Green tea varieties had 10~18% total catechins which accounted for 54~75% of EGCG and ECG. Among samples, domestic tea varieties, Chamnok, and Bohyang showed 11~14% or 20~24% higher amounts of total catechins and EGCG, compared to others. In addition, Chamnok green tea had the highest amount of caffeine and catechchin (EGCG and ECG) contents among green tea varieties. There were remarkable differences in the catechins contents according to different harvest periods. Fall tea leave contained the highest amount of catechins (200~250 mg/g DW) while spring teal leave did catechins (80~120 mg/g DW) content at samples. For anti-obesity effect, Chamnok green tea showed 1.7 times higher a-glucosidase inhibition and 2.5 times stronger repression on HMG-CoA enzyme, resulting in cholesterol synthesis, compared to other cultivars. Overall, those results indicate that domestic tea varieties, especially Chamnok contained higher catechins and stronger anti-obesity effects than other imported tea cultivars. ±<u>This study was financially supported by Rural Development Administration (Project No. PJ012565).</u>

Key words; Green tea, cultivars, catechins, anti-obesity

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Production of Yuzu Foaming Tablets and Its Physiochemical and Functional Properties *(Poster Board #080)*

Bo-Bae Lee*, Jellanamdo Agricultural Research and Extension Services; Seung-Hee Nam, Chonnam National University and Hye-sung Cho, Jeollanam-do Agricultural Research and Extension Services

Yuzu fruits and their products are widely consumed for their nutritional values and flavors. In addition, numerous studies have shown that yuzu fruit consumption is associated with a decrease in the incidence of cardiovascular disease. Yuzu pulp are the by-products of the citrus juice processing industries and account for 55–60% of the fresh fruit weight as wastes from process industries. Although it contains enriched health benefits flavonoids, such as phenolics (e.g., hesperidine and naringin) and vitamin C. In this study, Yuzu pulp was freeze-dried, pulverized, powdered up to produce foaming tablests. Physiochemical and functional properties of foaming tablests were studied on total phenolic and flavonoid contents and analyzed hesperinin and naringin compositions by HPLC analysis. Five foaming tablets were manufactured with 0, 5, 10, 15, or 20% (w/w) yuzu pulp powder, and Hunter color value of the foaming tablets (L value) tended to decrease with higher amount of yuzu powder. The foaming tablets with 20% yuzu powder had total phenolic and flavonoid contents with 96.67mg/100g, 67mg/100g, respectively. For functional flavonoids, foaming tablets with 20% yuzu powder showed highest hesperidine and naringin content with 1.97mg/100g, 12.38mg/100g, respectivley. Those results indicated that yuzu pulp podwers could be a potential nutritional and functional ingredients in food industry fields.

±<u>This study was financially supported by Rural Development Administration (Project No. PJ013826 022019).</u>

Keywords: Yuzu pulp, foaming tablets, hespridin,antioxidant activity

Specified Source(s) of Funding: * This study was financially supported by Rural Development Administration (Project No. PJ013826 022019).

Volatile Components and Chemical Qualities of *Viscum Articulatum* Burm.f. Hosted on Ancient Tea Trees *(Poster Board #081)*

Qiushuang Wang[1]; Junxi Cao[1]; Dong Chen[1]; Guihong Bi*[2] and Hualing Wu[1], (1)Guangdong Academy of Agricultural Sciences, (2)Mississippi State University

Mistletoe (*Viscum articulatum* Burm. f. (V. articulatum)) was a kind of parasitic plant hosted in ancient tea trees (*Camellia sinensis* (L.) Kuntze), which was consumed by locals for their health benefits. It has a unique flavor and aroma. Volatile flavor compounds (VFCs) in mistletoes were extracted by HS-SPME and analyzed by GC–MS. A total of 66 aroma compounds were identified including the alcohols, aldehydes, ketones, and esters, which accounted for 19.18%, 16.92%, 20.38% and 32.45%, on average, of the total aroma content in the tea mistletoe samples. The most abundant aroma components in tea mistletoe were benzaldehyde

(9.64%), followed by epoxy-β-ionone (7.71%), trans-geranylacetone (7.92%), and β-linalool (7.35%). Clean and lasting, sweet odor with wood, minor flowery and fruity aroma were its characteristics. Benzaldehyde (14.2%), phenethyl alcohol (13.08%), and β-linalool (10.41%) were the four most abundant aroma classes in oak mistletoes. It featured a heavy and lasting, fragrant aroma with minor floral scents. Benzaldehyde and β-linalool were the common aroma compounds in mistletoe samples. PCA showed that the two mistletoe samples were classified as one class because of the similar aroma compounds. While the tea samples (control) were classified as another class. Analysis of chemical components showed that main chemical components including polyphenols, caffeine, free amino acids, soluble carbohydrates and water extracts in tea samples (control) were significantly higher than that in the tea mistletoe. The content of water extracts accounted for 35.12% and 30.28% in tea mistletoe and oak mistletoe, while the total content of the polyphenols, caffeine, free amino acids, and soluble carbohydrates accounted for only 14.84% and 31.43% of the water extract, indicating there were still undetected compounds in mistletoe samples which need to be further studied. The sensory test showed that tea mistletoe had acceptable aroma and taste, which could be developed into alternative tea drinks in the future.

Local Food Systems (Poster)

Determination of Soft Skills Expected for Professionals in the Urban Food System Industry *(Poster Board #038)*

Kenny Artavia-Rojas; Candice A. Shoemaker*; Judy Favor; Cary L. Rivard and Eleni D. Pliakoni, Kansas State University

The importance of soft skills in professional and life success is not a new concept but there is growing awareness of these non-cognitive skills as part of the higher education experience, including in agriculture. In 2011 researchers identified seven soft skills needed for successful employment in agriculture, natural resources, and related careers and suggested they should be considered in curriculum revitalization. Currently, many universities successfully teach agriculture students technical skills and theoretical knowledge. However, to be successful, there is a clear and urgent need for agricultural professionals to acquire soft skills. The goal of the Urban Food Systems graduate program at Kansas State University is to prepare students for positions such as director/program managers in not-for profit organizations, city governments or extension programs in urban districts facilitating community gardens, urban farming, farmers markets, or farm-to-school programs. Thus incorporating soft-skill development within this graduate program is critical. The objective of this study was to determine what soft skills the urban food systems industry professionals (public, private, and nonprofit) expect when hiring new employees. A national survey was developed and targeted to a variety of national list serves (e.g. Comfood, North America Food System Network). Seven soft skills were examined: Experiences, Team Skills, Communication Skills, Leadership Skills, Decision Making/Problem Solving Skills, Self-Management Skills, and Professionalism Skills; and each soft skill was described through seven experiences. For example, *effective written communication* and *communicate pleasantly and professionally* are two of the seven experiences listed within Communication Skills. Respondents were asked to rank these experiences from most important to least important. Respondents were also asked to rank the seven major soft skill categories from most important to least important. Nonparametric analysis (Friedman Test) and Principal Component Analysis were used to determine differences among and within the seven groups using the statistical software XLSTAT ($P < 0.05$, n=73). Most of the respondents were from not-for-profit organizations (49%) or Cooperative Extension (18%) and were involved in the hiring process (67%). Overall, Professionalism Skills were ranked most important and Communication Skills and Team Skills were ranked least important. However, there were differences between those in Extension and Not-for-Profits and those that are involved in hiring and those that are not. Additionally, for most of the soft skills, there were also ranking differences across the seven experiences overall, as well as by where the respondents worked and if they were involved in the hiring process.

Specified Source(s) of Funding: USDA NIFA Higher Education Challenge Grant

Minimizing Risks in Production and Marketing of Locally Produced Value-Added Foods *(Poster Board #039)*

Eunjoo Cho; Renee Threlfall; Heather Friedrich* and Michael R. Thomsen, University of Arkansas

Local farmers and entrepreneurs in the food industry face challenges of highly perishable crops and competitive marketplaces thus need additional market avenues and means of aligning local supply and demand. Value-added food products provide an alternative use for local produce to extend market reach, expand product seasonality, and increase business income. Underserved small and/or beginning farmers and entrepreneurs lack the knowledge and facilities to move into value-added production. In addition, these farmers and entrepreneurs have limited resources to effectively create a marketing plan with a consumer-friendly narrative. The project team believes educational training in value-added production coupled with marketing plan strategies can address constraints facing small farms and entrepreneurs. The outreach program 'Keep It Local!' was developed to minimize risks in production and marketing of locally produced value-added foods in Arkansas. The primary sources of risk addressed were: (1) mitigating production risks inherent in expanding into value-added food production using locally grown crops; (2) reducing marketing risk for small and beginning farmers and entrepreneurs by developing effective messages that resonate with consumer interests in local foods; (3) demonstrating the potential to enhance profitability and reduce production risk in local food systems by improving local food processing and marketing. The project team delivered three workshops in Northwest, Central, and Eastern Arkansas in October 2018. The workshops provided an immersive and interactive opportunity for attendees to learn how to incorporate value-added operations and company branding for marketing strategies into their business plans. The program content included topics such as creating value-added, foods, horticultural considerations for value-added production, processing value-added foods, branding and marketing your business, business and marketing plans, marketing with social media, knowing your consumer, and telling about farm operation to reach your consumers. The workshop had 67 small farmers and entrepreneurs. Among workshop attendees, 10 participants applied for one-on-one assistance to create customized branding messages for their farm business or products. Project deliverables included workshop notebook and 10 unique marketing narratives. Keep It Local! project was managed by the University of Arkansas and University of Arkansas System Division of Agriculture funded by Southern Extension Risk Management Education Center and United States Department of Agriculture, NIFA program.

Specified Source(s) of Funding: by Southern Extension Risk Management Education Center, United States Department of Agriculture - NIFA program

Quantifying and Visualizing Orchards and Vegetable Crops Rate of Change Along the Wasatch Front, Utah *(Poster Board #040)*

Anthony Whaley*, Utah State University

Utah is undergoing rapid urban development on land that has traditionally been managed for agriculture. Development is particularly intense along the Wasatch Front and Cache Valley, where 94% of Utah's high value irrigated land is located. According to the *Your Utah, Your Future* survey, 97% of Utahns envision an increase in agricultural self-sufficiency and support a local food economy. Currently, Utah produces 134% of its protein, 95% of its grain, 26% of its dairy, 3% of its fruit, and 2% of its vegetables. By 2050, it is estimated that those percentages will decrease to 70%, 51%, 14%, 1.5%, and 1.1%, respectively (Utah County Agriculture Toolbox). Areas were delineated where agricultural land has been lost to development and three cropping systems (orchards, vegetable crops, and forages) were analyzed for rate of change. Using ESRI ArcPro's model builder, a tool was developed to select suitable growing areas where each cropping system could be transitioned based on each area's relief, soil characteristics, and water availability. Finally, geospatial visualizations were created using ESRI Story Maps and Google Earth to communicate these results effectively. Utilizing the natural landscape's biophysical parameters with this method will allow Utahns to visualize where specific cropping systems could be relocated in order to develop better informed land use strategies.

Engaging School and Family in Navajo Gardening for Health *(Poster Board #041)*

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In collaboration with the Dream Diné Charter School in Shiprock, NM, we developed a school garden intervention phased over 2017 and 2018 to increase fruit and vegetable consumption and reduce risk for obesity among Navajo families. Specifically, we aimed to:

1. Develop a new intervention: a) an enhanced school garden plot used as teaching space, b) a curriculum for elementary school children focusing on gardening & healthy eating; c) community gardening fairs to promote gardening and healthy eating in their families and throughout Shiprock.

2. Evaluate the feasibility of the intervention: participation and perceived engagement.

3. Develop a new tool for dietary assessment: culturally appropriate measure for diet of children and families in the Navajo Nation.

4. Evaluate the intervention to increase: a) healthy eating in students & their families; b) gardening participation; c) preparing healthy foods, and eating healthy foods; d) knowledge, self-efficacy and skills related to gardening.

Parents and students at the school helped develop the garden and curriculum through a serious if focus groups. Quantitative measures like "how many servings of fruits and vegetables" and "How often do you garden" were given at three time points. **Yéego Parent Focus Group:** There was value in having the garden at their child's school to see its potential impact on health and learning outcomes. **Yéego Student Focus Groups:** Students want to observe the life cycle of plants; they want to learn more about gardening; they want to eat what they grow (and grow things they like to eat); and students want to do activities that involve: drawing, reading, writing and math. **School garden development:** New approaches beyond community garden: Lessons were learned from the Life Lab (Santa Cruz, CA) visit which included: More signage, bench added. Quantitative measures including fruit and vegetable intake and confidence to garden pre and post intervention proved to be non-significant for most categories due to the low intensity of the evaluation. The lessons learned are being applied to a much larger project to be implemented in 2019.

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Plant Nutrient Management 2 (Poster)

Effects of Foliar-Applied Titanium (Ti) on Nutrient Leaf Tissue Content of Creeping Bentgrass (*Agrostis stolonifera*) on Professional Golf Course Greens in Central IL *(Poster Board #147)*

Caleb Wepprecht[1]; David Eliot Kopsell[*1]; Dean Kopsell[2] and Robert Rhykerd[1], (1)Illinois State University, (2)University of Florida

Professional golf course putting greens in the upper Midwestern U.S. typically consist of creeping bentgrass (*Agrostis stolonifera*) cultured on an engineered sand-based substrate. Creeping bentgrass is mowed at extremely short heights which limits root growth and makes mineral nutrient absorption difficult. Tytanit® is a commercial biostimulant product which combines S, Mg, and Ti-ascorbate. Previous studies of Tytanit® application to crops have reported increased essential nutrient uptake, but results have been inconsistent. No study to date has been performed on turfgrass using Tytanit®. Therefore, our objective was to determine the effect of foliar applied Tytanit® to L-93 creeping bentgrass putting greens on engineered sand-based rooting profiles at two locations in Central IL. Tytanit® treatments followed product label rates for horticultural crops (0.07% total spray volume) and agronomic crops (0.14% total spray volume) applied along with a non-ionic surfactant (Spreader Sticker, Lesco, Cleveland, OH) to plots using a boom sprayer (Smithco Spraystar 3180, John Deere HD 200) in a split plot experimental design in May of 2017. Each individual plot was 7.62 m long and 1.5 m wide with a 1.5 m wide buffer zone between each treatment. The total plot size was 7.62 m long and 22.86 m wide at each location. Strips of each treatment were made on turf surfaces and four replicated plots were sampled from within each strip. Soil samples were collected from each plot before Tytanit® application at 2 and 4 weeks after the application. Leaf tissue samples were collected from individual treatment and control plots from reel mower clippings prior to Tytanit® application and every 3 days during a 6-week period. Soil and tissue samples were analyzed for elemental content using Inductively Coupled Plasma (ICP) analysis by a commercial soil testing laboratory. Leaf tissue P ($P=0.07$), S ($P=0.01$), and Cu ($P=0.001$) content increased linearly after the 0.07% Tytanit® rate application, while leaf tissue Ca ($P=0.05$), P ($P=0,05$), and Cu ($P=0.03$) content decreased, then increased quadratically after the 0.14% Tytanit® rate application at one testing location. Uptake of all other essential elements were not significantly different than control plots. Nutrient uptake stimulation lasted between 4 and 10 days after the Tytanit® treatment. Titanium delivered as Tytanit® did impact creeping bentgrass nutrient uptake, but results were location and nutrient specific and further testing is needed to determine the benefit of application to professional turfgrass.

Specified Source(s) of Funding: Central Illinois Golf Course Superintendents Association

Isolation and Functional Characterization of the PHT1 Gene Encoding a High Affinity Phosphate Transporter from Camellia Oleifera *(Poster Board #148)*

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Plant phosphate transporters mediate phosphate acquisition, translocation, and recycling in plants. In this study, a putative protein high affinity phosphate transporter (GenBank KF989483.1) was isolated and characterized from tea tree (Camellia oleifera Abel.). The CoPht1;3 contained an 1575-bp open reading frame, encoding 525 amino acids residues. It shared 88.5, 86.5, and 85.6% amino acid identities with the Pht1s of Camellias sativa, Arabidopsis thaliana, and Hevea brasiliensis, respectively. The CoPht1;3 exhibited all essential motifs and 12 transmembran helix common to the Pht1 family of phosphate transporters, which α-helical structure accounted for 48.66%. The CoPht1;3 was localized in tonoplast by transient expression of CoPht1;3:eGFP in tobacco epidermal cells. Quantitative real-time PCR (qRT-PCR) analysis showed that CoPht1;3 mRNA was detected in root, leaves and stem, but its transcript was the most abundant in young leaves at low P supply. The results indicated that CoPht1;3 in response to Pi starvation might be a high Pi affinity co-transporter of H+/Pi. CoPht1;3 overexpression enhanced aborption of phosphorus and increased biomass of the transgenics. This study suggested that CoPht1;3 may play a key role in transportation process of phosphorus in oil tree leaves and could be further targeted as a candidate gene to improve tree P efficiency.

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Nitrogen Optimization for *Humulus Lupulus L.* in Iowa Soils *(Poster Board #149)*

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Hops (*Humulus lupulus* var. *lupuloides* 'Cascade') are considered an alternative crop for the Midwest region. Due to the crops non-traditional status, fertility and management guidelines have not been optimized for the region's environment and soil. We hypothesized that hop cone yield and quality will vary with varying amounts and forms of nitrogen fertilizer. To test our hypothesis seven levels of N fertilizer were applied in split application in the form of granular urea at rates of 0, 50, 100, 150, 200, 250, and 300 pounds per acre. Five combinations of three forms of N fertilizer were applied in split applications at a rate of 150 pounds per acre. The three forms were granular calcium nitrate (CN), granular urea (Urea), and liquid urea ammonium nitrate (UAN). Combinations are Urea/UAN, CN/UAN, Urea/Urea, CN/CN, and UAN/UAN. Overall plant weight increased with nitrogen concentration. There was no difference in yield per plant for those that received 50 to 250 lb of N/acre. Plants that received 0 lb of N/acre had lower yields, and those that received 300 lb of N/acre had higher yields. Overall yield per acre was not significantly different for any treatment. No significant differences were seen in yield per plant between N forms. Yield per acre varied by treatment with the CN:UAN combination producing significantly different yields than the other forms.

Specified Source(s) of Funding: Leopold Center for Sustainable Agriculture

Dynamics of Nitrogen, Phosphorus, and Potassium in Leaves of 'Arbequina' Olive (*Olea europea*) in Florida. *(Poster Board #150)*

Jonathan Clavijo-Herrera*; Jeffrey G Williamson; Michael J. Mulvaney and Mack Thetford, University of Florida

A burgeoning olive industry is already present in Florida. The production area is estimated to be approximately 400 acres. However, little information about the establishment and nutrition of olives in this region is currently available. Moreover, studies on the seasonal changes of the nutrient content in olive trees growing under local environmental conditions have not yet been reported. The purpose of this research was to develop nutrient curves for nitrogen, phosphorus, and potassium in 'Arbequina' olives in Florida, based on analysis of foliar samples. Trees from three commercial farms in the counties of Gilchrist, Marion and Suwannee were established under irrigation between two to five years prior to collection of leaves from April 2018 to March 2019. Compared to Gilchrist and Marion counties, the trends of all nutrients were different in Suwannee county, the northernmost location. The trends for phosphorus and potassium were similar in Gilchrist and Marion counties. Although not always statistically significant, lower nutrient content was mostly observed in olives from Marion county. Nitrogen content decreased from April until August, and then increased to levels similar to April in Gilchrist and Marion counties. Trees from Marion county presented the lowest nitrogen values from June to August. The phosphorus content in trees from all locations varied along the course of this study, but it was lower during spring (April) compared to winter (December) for trees from Gilchrist and Suwannee counties. Phosphorus content was similar during spring and winter for trees from Marion county. An accumulation of potassium was observed from April to August in Gilchrist county, followed by an abrupt decrease in September. Trees from Marion county presented the lowest potassium content from June to January, but it increased in March. Trees in Gilchrist and Marion counties increased potassium content around October and maintained similar levels through March. When considering the macronutrients N, P, and K, the optimal time for collection of foliar samples may be between June and July, under the conditions of this research.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant Program, Poject Number P0030013 - USDA CRIS Project 005445

Pre-Plant Fertilizer Evaluation in Strawberry Production in Northern California *(Poster Board #151)*

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Nitrogen management is one of the most challenging aspects of nutrient management in strawberry (Fragaria × ananassa) production, particularly in the California northern district (Watsonville and Salinas). Excess of nitrogen application results in potential for leaching and possibly in low fruit quality; low nitrogen availability for crop uptake can result in reduced yield. Plant nitrogen uptake is low from planting to the beginning of harvest (about 30 lb/ac from November to March), and moderate and constant from spring until crop termination (1 lb/ac day from April to September). Pre-plant slow-release fertilizers consisting of a formula of nitrogen, phosphorous and potassium coated by a polymer layer are commonly used in strawberry production. However, there are concerns on the rate of release of the fertilizer, and some evidence that much of the fertilizer may be released during winter months, when crop uptake is low and leaching potential due to rains is high. Therefore, some growers rely mostly on fertigation during spring and summer rather than on pre-plant applications to increase crop nitrogen availability. We conducted an applied research and extension experiment in collaboration with four commercial strawberry growers with the goal of informing nitrogen management and evaluating different strategies. Growers applied different rates of pre-plant fertilizer and some ranches supplemented nitrogen with in-season fertigation. We monitored nitrate in the soil monthly with soil nitrogen quick tests (MQuant nitrate test strips). There was substantial evidence of nitrate leaching by winter rains and some evidence of leaching due to over irrigation. We also found some evidence that fertilizer beads were still in the soil as late as June. In all ranches, residual nitrogen from the previous crop and nitrate in the irrigation water provided substantial contributions to the crop total nitrogen balance, contributing to a seasonal nitrogen availability over 300 lb/ac while the generally recommended crop demand is below 250 lb/acre. In one ranch, nitrate in the irrigation water and estimated nitrogen release from soil mineralization appeared sufficient to satisfy the rate of 1 lb/acre day of crop uptake. In one ranch, we measured yields on a strip plot with three replicates; the yield was about 10% higher for the pre-plant treatment than in the fertigation treatment, despite the first received from fertilizer a total of 117 lb of nitrogen/acre and the second 158 lb of nitrogen/acre. In conclusion, this work provided insight into pre-plant fertilizer availability and suggested in-season nitrogen fertigation management strategies for strawberry growers in northern California.

Specified Source(s) of Funding: Western SARE

Effect of Biochar on Muscadine Grape (Vitis rotundifolia. L) Growth and Nutrient Uptake

(Poster Board #152)

Yuru Chang*, University of Florida and Ali Sarkhosh, Univeristy of Florida

Muscadine Grapes (*Vitis rotundifolia*. L) are the predominant grape variety commonly grown in Florida, with current markets existing for juice, wine, and fresh fruit. They can adapt to the Florida environment better than *Vitis vinifera.* because they are naturally resistant to a local bacterial pathogen (*Xylella fastidiosa.* L) and are well-adapted to warm and humid climates. However, most Florida vineyard soil displays low soil fertility because of the sandy soil. The sandy soil is highly susceptible to erosion, depleted in organic matter contents and, therefore, in water-holding capacity and nitrate retention. There is some evidence suggesting that Biochar can adjust soil organic matter contents and buffer pH, and consequently stimulate soil microbial activity and sequestration capacity for nutrients. Improved fertilization using Biochar will not only enhance the sustainability, productivity and profitability of Florida wine grape vineyards and wineries, but also minimize the potential deleterious environmental impact of fertilizers leaching and runoff in grapes production facilities. Thus, this study intended to test the applications of Biochar to improve soil condition and muscadine growth and nutrient uptake in Florida's vineyard. We apply the Biochar at five different rates and monitor the soil characteristics, root development, plant growth and nutrient status. Our goal is to provide information for developing Biochar application and nutrient program guidelines for grapes producers to enhance whole vine nutrition management and increase total productivity.

Evaluating Manganese Toxicity of Lettuce Grown in Oxisol Soils with Low pH *(Poster Board #153)*

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Manganese is an essential plant nutrient that can become toxic to plants at high concentrations. Most of the production areas in Central Oahu have Oxisol soils (Wahiawa Series) that have been in pineapple production for many years. Due to the management practices associated with pineapple production, the average soil pH in these areas are near 4.5. These highly weathered soils are known to be naturally high in manganese which becomes soluble and toxic to plants under low pH conditions. To better understand how management practices affect the plants ability to uptake manganese in these low pH soils, lettuce was planted in one gallon pots containing oxisol soils and amended with common liming materials. Treatments included an unamended check, commercially produced compost at a rate of 20 tons per acre and calcium carbonate as Microna at a rate of 2.5 tons per acre. The starting unamended soil had an average pH of 4.5 and had a manganese concentration range of 648-934mg/dm^3. Soil amended with calcium carbonate and compost showed to increase pH to 6.3 and 4.8, respectively. Above ground biomass from both calcium carbonate and compost amended soils were significantly higher than that of unamended soils. Above ground biomass from calcium carbonate amended soils were numerically higher but not significantly different than biomass from soils amended with compost. Post-harvest tissue analysis showed manganese was significantly higher in plants grown in unamended soil than plants grown in soils amended with both compost and calcium carbonate. Although there were no significant differences in tissue manganese between soils amended with compost and calcium carbonate there were significant visual toxicity symptoms on plants amended with compost. This study provides valuable information that can be used to make management decisions in areas that have low pH and high soil concentrations of manganese.

Plasticulture (Poster)

High Tunnels Extend the Growing Season in Warm-Season Crops: Tomato, Bell Pepper and Cucumber *(Poster Board #082)*

Kyla Splichal*, North Dakota State University

High tunnels are used to modify the environment in which a crop is grown by trapping solar energy from the sun, providing protection from unfavorable weather events, and extending the growing season in temperate regions. Warm-season crops, like tomato (*Solanum lycopersicum* L.), bell pepper (*Capsicum annuum* L.), and cucumber (*Cucumis sativus* L.), benefit from a longer, warmer growing season. This project evaluated cultivar trials of tomato, bell pepper and cucumber grown under high tunnel production and compared with an outdoor field over two growing seasons. Nine cultivars of each crop were grown with yield and quality assessed across years and experiment locations, western and eastern North Dakota. In the 2016 season, a difference of only 8 days occurred between the planting of the high tunnel and the field trials because construction of the high tunnel was not yet complete. This resulted in minimal differences in yields from inside the tunnel to outside. In 2017, the tomatoes and peppers were planted 14 days earlier resulting in 1.5 and 1.6 times more production than the field, respectively; and the cucumbers planted 27 days earlier resulted in almost 6 times more production in the high tunnel than the field. The 2017 high tunnel bell pepper trial at both locations was plagued with diseases and insect infestations resulting in the significant cultivar x location x year interaction. The main effect, cultivar was not significant which could indicate uniformity among cultivars. The uniformity of cultivars was also reflected in the outdoor field, with only significance found in the location x year interaction and the main effect, year. The cucumber cultivar 'Corinto' had the greatest yield from inside the high tunnel across years at 17 kg/plant^{-1} in the western, and 20 kg/plant^{-1} in the eastern trial. The field conditions proved to be more variable with no particular cultivar that stood out as the top producer in any given location or year. The western 2017 tomato high tunnel trial was also plagued with severe viruses resulting in the termination of the trial. The outside western tomato trial however, continued, as did the eastern high tunnel and field tomato trials for both years. High tunnels have extended the season, improved crop quality, and increased production relative to normal field growing conditions in North Dakota.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant

A Fast and Farmer-Friendly Method of Assessing Biodegradable Mulch Fragments in Soil *(Poster Board #083)*

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Biodegradable mulches (BDMs) provide many of the benefits of polyethylene mulch (PE), without the disposal issues of PE. BDMs are tilled into the soil at the end of the growing season, breaking down to CO_2, water and microbial biomass. Various attempts have been made to monitor degradation of BDM macro-fragments in the soil, and thus far, these methods have been time consuming and inaccurate. No quick assessment method is available to growers and researchers to monitor and quantify BDM degradation. This study took place in conjunction with experiments growing pumpkin (2015-2016) on four black BDM (OrganixAG, NatuRecycle, BioAgri/Bio360, and PLA-PHA), black PE mulch, brown cellulose (WeedGuardPlus (WGP)) mulch and bareground treatments. In 2017-2018, pepper was grown in the same field and all mulches were the same with the addition of a white-on-black (WOB) BDM treatment. In all years of the study, BDMs and cellulose mulch were tilled into the soil in the same plot locations at season's end. We assessed a simple method using a meter-squared PVC quadrat tossed randomly on the bed within a day after tillage, then counting and estimating the area of mulch fragments recovered on the soil surface in both spring and fall of 2016, 2017 and 2018. As expected, more fragments were recovered in fall directly after tilling mulches into the soil. An increase in fragment recovery in fall 2016 versus 2017 was likely due to drought in 2016 slowing degradation. Moreover, the spike in mulch recovery in fall 2018 in Organix, PLA-PHA, and WOB likely was caused by extreme nutsedge pressure, which lifted the mulch and prevented mulch-soil contact, as well as more exposure of the mulches to UV rays, due to heat-induced plant stunting directly after 2018 planting. Spring mulch fragment recovery was under 100 $cm^2/m^2$for all treatments, except for PLA-PHA in spring 2018. This increase in PLA-PHA fragment recovery may be due to increased brittleness of the mulch roll as the study progressed. The WOB BDM treatment was added in 2017, and, therefore, only tilled in two seasons. Thus far, the WOB seems to be degrading comparably to black BDMs. PE, bareground and WGP plots were almost completely free of mulch fragments, which gives an estimate of washing or blowing of fragments from plot-to-plot. In conclusion, the data show that this method is a quick and easy way to monitor BDM degradation in the field from year to year.

Temperate Tree Nut Crops (Poster)

Training Nursery Growers in Macadamia Grafting and Best Management Practices for Orchards in Western Kenya with Catholic Relief Services and the USAID Farmer-to-Farmer Program

(Poster Board #292)

Dilip Nandwani and ZaDarreyal Wiggins[*], Tennessee State University

Growing fruits and nuts offers tremendous opportunities for enhancing the incomes of small-scale farming families in Kenya, and for improving the nutrition of the poor who currently suffer from deficiencies in vitamins, minerals and other micronutrients because of low consumption of these foods. Macadamia nuts and fruit trees are popular crops but having issues sustaining production. The Good Neighbors Community Project (GNCP), a women-run community based organization in Naitiri, Bungoma district. The main objective of the volunteer assignment is to build the capacity of GNCP selected farmer trainers through a Training of Trainers mechanism (TOT) on macadamia propagation and grafting, nursery management, and good agronomic practices for high production. Hands on training, live demonstrations, field visits and classroom lectures performed to give multiple viewpoints of how to improve grafting practices in macadamia. Grafting tools, side wedge, veneer and cleft grafting procedures demonstrated on macadamia. Seedbed preparation, pruning and grafting techniques, rootstock and scion selection, natural pest control and good agricultural practices topics discussed to maintain a successful orchard.

Increased knowledge and understanding of grafting, fruit tree propagation, pruning and how these techniques affects farm production were among the immediate impacts recorded from the training. Total two hundred sixteen participants (male and female) benefitted from the training.

Specified Source(s) of Funding: POTUS

Evaluation of Hybrid Hazelnut Phenology to Determine Usefulness As Pollenizers *(Poster Board #293)*

David Hlubik*; John Michael Capik; Adam D'Angelo; Alex Mayberry and Thomas J. Molnar, Rutgers University

Two limiting factors of European hazelnut (*Corylus avellana*) cultivation in the northeastern US are the disease eastern filbert blight (EFB) and lack of cold hardiness of catkins (male flowers). Several EFB-resistant *C. avellana* breeding selections have been developed at Rutgers University and are near the point of commercial release; however, cold-hardy disease-resistant pollenizers have not yet been developed. Hazelnuts are monoecious, wind-pollinated, and self-incompatible. Therefore, more than one compatible genotype must be planted in an orchard for successful nut set. Clonal pollinizers that possess both cold hardiness and high quality nuts are desirable for the long term success of an eastern hazelnut industry. Their pollen shed period must also overlap the exertion of pistillate blooms of the main nut producing genotype(s) in the orchard. One approach to developing these plants is to utilize the native American hazelnut, *C. americana*, which is adapted to very cold regions, as both a donor of EFB resistance and cold hardiness of catkins. In this study, a large population of *C. avellana* × *C. americana* F_1 and advanced generation hybrids planted in 2012 were evaluated for response to EFB, nut and kernel qualities, and relative numbers of catkins/catkin health (lack of winter injury). Out of a population of over 2,300 trees from more 30 controlled crosses, 60 superior trees were selected from 16 progenies. These 60 selections were observed twice per week over winter 2018/2019 for phenology of male and female flowers and vegetative bud break in comparison to a panel of known European hazelnut cultivars. Results showed that the hybrid selections, while largely free from winter damage, were highly variable in their timing of pollen shed. A number of the selections appeared to bloom too late to provide adequate pollen coverage for most European hazelnuts. However, a subset bloomed at the correct time according to this year's flowering period and included early-, mid-, and -late blooming options for European hazelnuts. These selections will evaluated for phenology again in 2020, with their S-alleles identified, pollen fertility examined, and the most promising clonally propagated and tested in multiple locations including New Jersey, Nebraska, Wisconsin, and Minnesota.

Specified Source(s) of Funding: USDA-NIFA Specialty Crops Research Initiative Competitive Grant 2016-04991 and 2009-51181-06028

Assessing Water Use Efficiency in Field-Grown Pecans Under a Partial Root Zone Drying Irrigation Regime *(Poster Board #294)*

Curt A. Pierce*; Blair L. Stringam and Richard J. Heerema, New Mexico State University

Partial root zone drying (PRD) is an irrigation method that utilizes alternating, localized water applications to produce a staged, simultaneous, wet/dry cycle between the two halves of a root system. The goal of PRD is to increase water use efficiency (WUE) by stimulating certain drought stress related responses in the plant. This study investigates the primary effects of a PRD regimen on drip-irrigated, field-grown 'Pawnee' pecan [*Carya illinoinensis* (Wangenh.) C. Koch] in south central New Mexico, USA, where the pecan production area is rapidly growing while the availability of water resources is declining. Comparisons of photosynthesis (Ps), stomatal conductance (g_s), midday stem water potential (Ψ_{smd}) measurements and various yield factors were made in the 2018 growing season between five irrigation treatments, including PRD applications at both 100% and 75% of estimated evapotranspiration (ET) levels. Results did not indicate a strong response to PRD treatments over a single season. Variations in Ps, g_s, Ψ_{smd} and measured yield factors were all relatively small, with only a single PRD treatment incorporating a 25% deficit during the earliest growth stage showing minor improvements in yield and average nut weight (4.67% and 4.18%, respectively) over the control. Further research will determine if PRD effects on WUE become more pronounced over time and if there are carry-over effects of PRD on return bloom or nut production.

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Training Systems Affect Growth and Reproductive Traits in Different Almond Cultivars *(Poster Board #295)*

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Harvest process in almond is commonly done in several steps starting from shaking the trees, drying nuts on the orchard floor followed by blowing, sweeping and final harvesting by pickup machines. Sweepers and blowers create significant amount of airborne particles and drying nuts on the orchard floor has several environmental and food safety issues. Therefore, the main goal of this study is to facilitate using over-the-canopy harvester for almond varieties with more vertical structure and to understand how they differ in growth habit in response to different types of training systems. Trees of four almond cultivars, Monterey, Wood Colony, Nonpareil and Shasta, were planted in

Fresno, CA in February 2018 and the trees were trained to either traditional open center (P1 and P2) or central leader training system (CL1 and CL2). P1 trees were subjected to a heading cut plus trimming of side branches in the nursery and no further pruning; while P2 trees received a narrow "palmette" pruning in the field in second year, in addition to P1 treatment at planting. CL1 trees received no heading cut or trimming in the nursery and no further pruning, while CL2 trees also received no heading cut in the nursery, but their side branches were trimmed at the nursery to produce a "bare pole". Results of full bloom data showed significant differences among both the cultivars and training treatments, with Non-pareil, Shasta and Monterey blooming significantly earlier than Wood Colony. P2 trees showed significant bloom earliness in comparison with P1 and CL1, followed by CL2. Tree height was also significantly different among cultivars and pruning treatments. On average among the cultivars, the tallest cultivar was Shasta (268.6 cm) and the shortest was Monterey (250.3 cm) while the CL2 treatment was tallest among training treatments (287.0 cm) and P2 the shortest (239.8 cm). Data showed significant difference for all measured parameters for cultivar effect but bloom number and fruit number also showed significant differences among pruning treatments.

Specified Source(s) of Funding: Almond Board of California/CSU ARI

Investigating Nickel Nutrition to Photosynthesis and Mouse-Ear Severity of Pecan in the San Simon Valley, Arizona *(Poster Board #296)*

Joshua Sherman*, University of Arizona

In the past several decades, southwest pecan (*Carya illinoinensis*) production has been steadily rising in its contribution to total U.S. yield. Soils in the southwest pecan growing areas are typically alkaline and calcareous (>7.5 pH); thus phosphorus and most micronutrients, including Nickel (Ni), are poorly available for root uptake. Nickel deficiency disrupts the normal nitrogen metabolism in plants. Symptoms of Ni deficiency ("mouse-ear") are commonly seen in Arizona pecan orchards. One of the many known functions of Ni within the plant is to activate the enzyme urease that converts nitrogen into a usable form for leaf and shoot expansion in the spring. There is currently no recommended level of Ni in pecan leaf tissue in Arizona. Researchers in Oklahoma and New Mexico have recommended >2-3 ppm in leaf tissue of pecan. Southeast Arizona pecan orchards are frequently below that level. Currently in research there is no information on the effect of Ni deficiency to photosynthesis. Our approach is to characterize the relationship between leaf Ni concentration, photosynthesis, and mouse-ear severity. In 2016 and 2017, an experiment was conducted on 6.5 hectares of 8th leaf 'Western Schley' and 'Wichita' pecan trees in San Simon, AZ. There were two treatments with three replications in which 1) $NiSO_4$ (10% nickel sulfate) was foliar applied (946 ml per 0.4 hectare) with two applications during the growing season, and 2) no application of Ni (Control). Gas exchange was measured using a portable photosynthesis system and correlated to leaf Ni tissue concentrations. Mean leaf Ni concentration in 2016 was 0.7 and 3.6 ppm in the Control and Ni-treated, respectively. Concentrations in 2017 were 4.9 and 15.9 ppm in the Control and Ni-treated, respectively. All other nutrients were within normal ranges. Analyzed by year, in 2016 Ni-treated pecan trees had significantly higher photosynthesis and stomatal conductance ($\alpha = 0.05$) than the Control. In 2017, the difference of treatments in relation to photosynthesis was not significant. Due to possible drift, a third year of treatments (2018) was issued with the same treatments except expanding the treated area for added buffer. The results of 2018 measurements will be presented for discussion.

Specified Source(s) of Funding: Arizona Department of Agriculture Specialty Crops Block Grant Program SC-BGP-FB-04

Molecular Approaches to Decipher Alternate Bearing in Pecans *(Poster Board #297)*

Kiah S. Lowe; Hormat Shadgou Rhein; Jennifer J. Randall; Richard J. Heerema and Rolston St. Hilaire*, New Mexico State University

Alternate bearing (AB), which is defined as an "ON" year with an overabundance of fruit followed by an "OFF" year with few if any fruit, can be a persistent production issue for pecans. Similarly, conditions which can induce AB have not been investigated at length. Key events that initiate and perpetuate an AB cycle are: (1) an environmental factor (such as temperature) that triggers a stress response, (2) a molecular cascade that follows a stress response, causing epigenetic changes and a disruption of homeostasis in favor of defense and resource conservation, and (3) persistence of homeostatic disruption that affects the following year's physiological status. Our current research seeks to unveil the molecular mechanisms associated with initiating and maintaining an AB cycle. The relative mRNA levels of a selection of candidate genes will be tracked based on: (a) those involved in repression of floral induction, such as *FLC* and *TEM1*, in low-AB or regular-bearing (RB) cultivars subjected to different temperature stresses during dormancy to distinguish the onset of AB, and (b) those involved in reproductive organ abscission, like *SEP* and *JOINTLESS*, and vascular differentiation, like *SUC1* and *VND7*, over a two-year period in RB and AB cultivars. Currently, we have identified putative temperature-responsive motifs including MYCCONSENSUSAT and MYB1AT in the promoter regions of apple abscission genes. We intend to use apple sequence data to distinguish related regions in pecan. We will also determine DNA methylation patterning, RNA-seq gene expression, and physiological differences between the two groups. Orchard management techniques such as mechanical and chemical thinning that are used to mitigate the impact of pecan AB are expensive, tedious, and raise health and environmental concerns. Thus, the long-term goals of this project are to: (i) work toward specifying a definitive measure of genotyping for AB severity, and (ii) lay the groundwork for developing RB cultivars through gene editing.

Specified Source(s) of Funding: SCRI

Vegetable Breeding 3 (Poster)

Developing Edamame Varieties for Better Adaptation and Improved Consumer Acceptance to Increase Domestic Production *(Poster Board #274)*

Bo Zhang*[1]; Pengyin Chen[2]; Leandro Mozzoni[3]; Thomas Kuhar[1]; Steve Rideout[1]; Ramón A Arancibia[1]; Jeremy Ross[3]; Susan Duncan[1]; Haibo Huang[1]; Yun Yin[1]; Mark Stephen Reiter[1] and Clinton Neill[1], (1)Virginia Tech, (2)University of Missouri, (3)University of Arkansas

Edamame has quickly become the second largest soy-food consumed in the U.S. (around 25,000 to 30,000 tons annually), but no less than 70% of edamame rely on imports. To reverse this condition, stakeholders identified the need for improved varieties to overcome the main barriers including mechanical harvest, weed management and consumer acceptance. Therefore, the objective of this project is to breed new edamame varieties with better adaptation than commercial cultivars with exotic background, and improved appearance and flavor. Twenty-four advanced edamame breeding lines and three commercial edamame cultivars as checks were grown in Blacksburg, VA, Painter, VA and Little Rock, AR in 2018. Pest evaluation such as soybean aphids and damaged pod number, edamame quality data such as pod length and weight of 10 pods, bean compositions such as sugar content, sensory evaluation data such as appearance and taste were collected from one to three locations. Results showed that there are potential breeding lines performed similar or better than the checks. For example, V16-0547 received the highest score of the consumer acceptance of 6.09, a little better, but not significantly, than the check of Asmara, 6.05, particular in Painter, VA (6.44). R14-6238 also showed long pods of 48.7 mm, very close to the check with the largest pods (49 mm). The significant variation of soybean aphids and other diseases was also observed among breeding lines. The data of breeding lines are still under analysis, so the decision of breeding selection will be reported at the conference. We will continue the trial using selected advanced breeding lines and new advanced lines at the same locations in 2019, and plan to release superior edamame varieties with two-year trials in 2020.

Genome-Wide Association Study and Genomic Selection for White Rust Resistance in Spinach *(Poster Board #275)*

Jun Qin[1]; Ainong Shi*[1]; James Correll[1]; Carlos A. Avila[2]; Chunda Feng[1]; Bo Liu[1]; Gehendra Bhattarai[1]; Bazgha Zia[1] and Waltram Ravelombola[1], (1)University of Arkansas, (2) Texas A&M AgriLife Research

White rust, caused by *Albugo occidentalis* is a severe disease of economic importance that causes reduction in yield and quality in spinach (*Spinacia oleracea* L.). The use of resistant cultivars is economical and practical approach for white rust management. The objectives of this research are to evaluate white rust resistance in a panel of world-wide spinach germplasm, and to conduct genome-wide association study (GWAS) and genomic selection (GS) for white rust resistance in spinach. A total of 910 spinach genotypes were evaluated over 4 years at the Del Monte White Rust Nursery in Crystal City, TX. Over 100 spinach genotypes out of 910 were selected with levels of quantitative resistance to white rust pathogen. In our earlier research, GWAS and GS were analyzed in an association panel with 412 spinach genotypes using 3000 SNPs from ddRADseq and eight SNP markers were associated with white rust resistance. Based on RR-BLUP in rrBLUP, using 250 spinach genotypes as training set and 162 genotypes as validation set, the correlation coefficients (r) between genomic estimated breeding value (GEBV) and observed value of white rust resistance averaged 0.68 with the eight SNP markers. Currently GWAS is being conducted in 480 spinach genotypes including USDA spinach germplasm from over 30 countries, spinach commercial hybrids and Arkansas lines. Whole genome resequencing (WGR) is conducted with 10X genome coverage in BGI. It is expected that QTLs/genes and associated SNPs will be identified for white rust resistance in spinach and SNP markers could be used in spinach molecular breeding through MAS and GS.

Evaluation of a Detached Leaf Inoculation Method to Screen for Resistance to Downy Mildew in Spinach *(Poster Board #277)*

Gehendra Bhattarai*; Chunda Feng; Braham Dhillon; Ainong Shi and James C. Correll, University of Arkansas

Downy mildew, caused by the obligate oomycete *Peronospora effusa* (= *P. farinose* f. sp. *spinaciae* [Pfs]), is the most economically important disease of spinach. The emergence of new races of the pathogen continue to overcome the new genetic resistances used in newly released resistant cultivars. Genetic resistance to Pfs in spinach governed by a number of major dominant genes (RPFs) are widely used in all major hybrid spinach cultivars. Characterizing races of the downy mildew pathogen, breeding and selection for resistance in spinach rely on a labor intensive screen on whole plants in a large tray format in temperature controlled growth and dew chambers. Resource efficient disease screening techniques minimizing space, greenhouse resources, seed, and labor could greatly improve both race typing and efforts to screen for disease resistance. The objectives of this work were to evaluate, validate, and standardize a detached leaf inoculation method to quantify downy mildew disease response and to differentiate resistant and susceptible spinach genotypes. Detached spinach leaves in petri dishes were inoculated by spraying a spore suspension followed by standard incubation protocols. Disease incidence and severity on detached leaves were compared to the corresponding variety in the standard whole plant assay. The downy mildew pathogen was found to infect, propagate, and maintain pathogenicity on the detached spinach leaves. A high positive correlation (|r| > 0.90) between disease incidence and disease severity was found between detached leaves and whole plant inoculations. The detached leaf assay was able to discriminate between the expected susceptible and resistant reactions and could greatly reduce the resources needed for whole plant evaluations.

Mapping of Resistance to Downy Mildew Race 16 in Spinach Cultivar 'Whale' *(Poster Board #278)*

Gehendra Bhattarai*[1]; Ainong Shi[1]; James C. Correll[1] and Beiquan Mou[2], (1)University of Arkansas, (2)USDA-ARS
Downy mildew, caused by the oomycete *Peronospora effusa* [=*P. farinosa* f. sp. *spinaciae*] is the most devastating disease in spinach. Utilizing host genetic resistance is the most effective disease management method particularly for organic production. Identification of new resistant sources and understanding the genetic basis of disease resistance mechanism is crucial to sustain the spinach industry in the United States. The Pfs shows race specificities to the resistant host and 17 races have been reported in spinach. Over 10 new Pfs races were identified in the last two decades and the new races overcome the resistance genes deployed in the released resistant cultivars. Rapid emergence of new races and subsequent breakdown of resistant genes demands search for new resistance sources, developing linked marker, and incorporating the resistant loci into elite cultivars. To identify the molecular markers linked to resistance against Pfs16, we investigate spinach F2 population generated from a cross of Whale x Lazio. Whale is resistant to Pfs16 while Lazio is susceptible. Seedling progenies were inoculated with Pfs16 in the growth-dew chamber facility and were scored for disease response. The downy mildew disease response fits a 3:1 segregation ratio (P = 0.7) implying dominant allele governing the resistance mechanism. DNA from parents and all progeny were submitted for genotyping by sequencing (GBS). Single nucleotide polymorphism (SNP) markers identified from GBS will be used to construct a genetic map and map the resistance locus. Tightly linked SNP markers and the flanking sequences identified following the mapping effort will be used to screen for candidate genes involved in disease resistance. The newly identified markers linked to the resistant allele can be used in marker-assisted selection and pyramiding of multiple resistance genes.

Evaluation of Reduction in Plant Height, Stem Diameter, and Chlorophyll Content Among 331 Cowpea Genotypes Under Drought Stress at Early Vegetative Stage *(Poster Board #279)*

Waltram Second Ravelombola* and Ainong Shi, University of Arkansas
Cowpea [*Vigna unguiculata* (L.) Walp] is a diploid legume species (2n=2x=22) widely cultivated in Africa, Asia, southern Europe, southern and western U.S., Central and South America, the Middle East, and Oceania. The estimate of cowpea seed production is about 5.4 million tons globally. Drought stress has been one of the most important abiotic stresses affecting crop production worldwide. Water deficit conditions can lead to a significant yield decrease in cowpea. Breeding for more drought-tolerant cowpea cultivars would be vital to limit the impact of drought stress on cowpea production. This can be done by exploring different loci that potentially contribute to drought tolerance. Reduction in plant height, stem diameter, and chlorophyll content could be used as parameters to evaluate tolerance to drought conditions in cowpea and can lead to the discovery of new drought-tolerant loci. Therefore, the objective of this study was to evaluate the variation in decrease in plant height, stem diameter, and chlorophyll content in cowpea under drought stress. A total of 331 cowpea genotypes were evaluated for drought tolerance under greenhouse conditions and organized in a Randomized Complete Block Design (RCBD) with 3 blocks. Plant height, stem diameter, and chlorophyll were evaluated prior to applying drought stress, when 50% of the susceptible control (PI25574) showed chlorotic leaves, and when the susceptible control was completely dead. Drought tolerance index ((Non-stress – Stress)/(Non-stress) x 100), stress indicator 1 ((Final/Before stress) x 100), and stress indicator 2 ((Data when 50% of susceptible control showed chlorotic leaves) /(Before stress)) x 100) were calculated for each trait The preliminary results showed a large variation in those traits among the 331 cowpea accessions. These results will be useful in breeding programs developing drought-tolerant cowpea cultivars.

Variation in Plant Greenness Score, Wilting Status, and Leaf-Related Traits in a Diverse Set of Cowpea Genotypes Under Drought Conditions *(Poster Board #280)*

Waltram Second Ravelombola* and Ainong Shi, University of Arkansas
Cowpea is a legume species that can better withstand drought conditions compared to other legumes, so it can be used as a model crop to enhance our understanding of drought tolerance. Witling status and leaf chlorosis have been previously demonstrated to be a good indicator of drought tolerance in cowpea at early vegetative stage. Being provided with these phenotypic information would help cowpea breeders improve elite genotype being deficient in drought tolerance trait and scientists better understand the mechanism underlying drought tolerance. Therefore, this study aimed at evaluating a total of 331 cowpea genotypes for wilting status, leaf-related traits, and plant greenness score under drought stress at early vegetative stage. A total of 331 cowpea genotypes were evaluated for drought

tolerance in a greenhouse using a Randomized Complete Block Design (RCBD) with 3 blocks. A tolerant control (PI293568) and a susceptible control (PI255774) as previously reported were used to validate the experiments. Data on plant greenness score, wilting status, plants showing chlorotic unifoliate leaves, chlorotic first trifoliate leaves, ratio between chlorotic trifoliate leaves and green trifoliate leaves, and plants displaying dead growing point were recorded. Data will be analyzed using ANOVA in SAS v. 9.4 and mean separation will be done using a protected LSD at α=0.05. The preliminary results showed a large variation in those traits among the 331 cowpea accessions. Weak to strong Pearson's correlation coefficients were identified among the traits. These findings can be applied in cowpea breeding programs to improve tolerance to water deficit conditions.

Vegetable Crops Management 3 (Poster)

Infrared Thermography Applications in Stomatal Conductance and Drought Stress *(Poster Board #124)*

Amanda Lewis*, Texas A&M University Kingsville and Texas A&M University

Infrared thermography is a non-contact measurement which allows us to visualize the temperature of an object by measuring the objects emittance of long wave radiation. Previous research has found a relationship between thermal imaging parameters and stomatal conductance. Stomatal conductance is a parameter frequently measured in plant science research; primarily to determine the effects of stressors on stomata and plant water relations. This measurement gives us insight into plant photosynthesis and the impact of stress on plants. Stomatal conductance can be influenced by various abiotic stressors, including drought. Porometry is a common method of stomatal conductance measurement, which requires contact with the leaf surface. This can cause disturbance of the boundary layer and effect light interception and temperature at the point of measurement. These disturbances can induce stomatal response and in doing so, influence the measurement being taken. Thermal imaging offers multiple advantages over porometry for measurement of stomatal conductance. Thermal imaging is well suited for automation, scalable, non-contact and can generate large amounts of data in a short timeframe. The objective of this study is to explore applications of thermal imaging during plant development and post-harvest. Aspects of this study include defining the relationship between thermal image parameters and stomatal conductance in *Capsicum annum* L. under ambient and drought stressed conditions, using thermal imaging to quantify and visualize dynamic stomatal response to drought stress, as well as post-harvest quality analysis. Three image analysis methods were used to explore the relationship between thermal imaging parameters and stomatal conductance. Thermal images captured under summer greenhouse conditions found no significant correlation between the two parameters. To determine if extreme temperatures were a factor in these findings, the experiment was repeated under winter greenhouse conditions. Drought stress treatments were also applied to plants to evaluate if induced stress could impact results. Thermal images were captured and, stomatal conductance, chlorophyll fluorescence, relative turgidity and membrane permeability were measured.

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LED and Fluorescent Lighting Effects on Hydroponically Grown Hawaiian Chili Pepper and 'Koba' Green Onion *(Poster Board #125)*

Kent D. Kobayashi*, University of Hawaii at Manoa and Teresita D. Amore, University of Hawaiʻi at Mānoa

Food safety, environmental impact, and efficient energy usage are growing concerns in horticultural production systems. Using artificial lighting in producing chili pepper and green onions could be a solution to address these concerns. The objective of this study was to compare the effects of LED lighting and fluorescent lighting on the growth of young Hawaiian chili pepper plants and 'Koba' green onion plants in a noncirculating hydroponic system. Chili pepper (Capsicum frutescens L. 'Hawaiian') seeds were started in Oasis® cubes under T5 high output fluorescent lighting in the lab. Seedlings were then transferred to 5.1-cm net pots, which were placed in 1.9-liter containers containing a hydroponic nutrient solution of Hydro-Gardens' Chem-Gro lettuce formula 8-15-36 hydroponic fertilizer with added calcium nitrate (19% Ca and 15.5% N) and magnesium sulfate (9.8% Mg and 12.9% SO_4). Half of the seedlings were grown under red+blue+white LED lighting and half under T5 high output fluorescent lighting (99 µmol/m^2/s, 12-h photoperiod). 'Koba' green onions (Allium fistulosum L.) seeds were started as previously described. Seedlings were grown under T5 high output fluorescent lighting, 1.7:1 ratio blue:red LED lighting, or red LED lighting (119 µmol/m^2/s, 12-h photoperiod). At the end of the study, for chili pepper plants, stem diameter 1 cm above the Oasis cube surface was significantly greater with the LED lighting than the fluorescent lighting. There were no significant differences in plant height, SPAD reading, leaf dry weight, stem dry weight, root dry weight, and total plant dry weight. In addition, there were no significant differences in partitioning of dry weight into leaves, stems, and roots. For green onion plants, plant height and leaf dry weight were greatest with the red LED lighting, with no significant differences between the blue:red LED lighting and fluorescent lighting. Plants under fluorescent lighting grew tipped over or leaning over, while plants under the red LED lighting grew upright. Plants under the blue:red LEDs showed a mixed response with some plants leaning over and some plants upright. In conclusion, red+blue+white LED lighting could be an alternative lighting source to fluorescent lighting for young Hawaiian chili pepper plants. Red LED lighting enhances growth of young 'Koba' green onion plants.

Specified Source(s) of Funding: Hatch

Simulated Martian Soil for Hydroponically Grown 'koba' Green Onions *(Poster Board #126)*

Kent D. Kobayashi*, University of Hawaii at Manoa

In establishing colonies on Mars, food crops will need to be grown. Assuming that Earth soil or growing media will not be taken to Mars because of the expense, crops would most likely be grown in soil on Mars or grown hydroponically. As an alternative to adding organic matter to the soil, could the Martian soil be used in combination with the nutrient solution in a hydroponic system? The objective of this study was to determine the effects of simulated Martian soil in a noncirculating hydroponic system on the growth of 'Koba' green onion plants. 'Koba' green onions (Allium fistulosum L.) seeds were started in Oasis® cubes under T5 high output fluorescent lighting in a lab. Seedlings were then transferred to seedling starter trays. In the simulated Martian soil treatment, 20.5 g of soil was added around each Oasis cube in the cell with the soil reaching the top level of the Oasis cube. The simulated Martian soil was The Martian Garden's unsorted grade MMS-1 Mars Regolith Simulant. The other treatment was the hydroponic solution. The seedling starter trays were placed in small trays, and 500 ml of a hydroponic nutrient solution was added to each tray. The nutrient solution was Hydro-Gardens' Chem-Gro lettuce formula 8-15-36 hydroponic fertilizer with added calcium nitrate (19% Ca and 15.5% N) and magnesium sulfate (9.8% Mg and 12.9% SO_4). The seedlings were grown under red LED lighting (119 μmol/m^2/s, 12-h photoperiod). One hundred ml of the nutrient was added daily to the trays. At the end of the study, there were no significant differences between the simulated Martian soil treatment and the nutrient solution treatment for plant height, total leaf length, average leaf length, number of leaves, leaf dry weight, and stem diameter. In conclusion, the simulated Martian soil could be used in conjunction with the nutrient solution in a noncirculating hydroponic system.

Specified Source(s) of Funding: Hatch

Marketable Yield Performance of Seven Heirloom Varieties of Tomato in Delaware *(Poster Board #127)*

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Delaware producers are looking for heirloom tomato varieties to attract more consumers to retail farm operations. In 2017/18, seven different heirloom varieties of tomato (*Lycopersicon esculentum* Mill.) were tested for production characteristics and fresh market suitability in Delaware. Tomato seedlings were transplanted into a well-drained loamy soil at the Outreach and Research Center of Delaware State University, DE. A completely randomized block design was used with three replicates for each variety. Each replicate consisted of 10 plants per variety. Row spacing was 1.2 m, and between row, spacing was 2.4 m. ', 'Brandywine,' 'Big Red', 'Glacier,' 'Moskvich,' 'Roma,' 'Amish Paste,' 'Rose.' Varieties were produced using plastic mulch beds and drip irrigation. 'Roma' served as a control. Plants were fertigated weekly using a balanced liquid supplement or nitrogen based on extension recommendations for Delaware. Tomatoes were harvested weekly (10 total harvests), and marketable fruits were separated from damaged one. Findings include: 'Rose' produced significantly greater total marketable yield by weight after Roma. Variety and year interaction were found significantly different due to the different amount of rain in the different year. When comparing total marketable yield, on an average, 'Roma' showed the highest yield (28800 kg/ha), followed by 'Rose' (28100 kg/ha), 'Amish Paste', (21600 kg/ha), 'Big Red' (20900 kg/ha), 'Moskvich' (20100 kg/ha), 'Brandywine' (18900 kg/ha) and 'Glacier' showed the lowest yield (18300 kg/ha). This trial showed that heirloom varieties could be a good source of income to producers and variable taste to consumers.

Productivity of Asian Vegetables in South and Northeast Texas *(Poster Board #128)*

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Asian vegetables have a great potential to help Texas growers meet the demand of increasing Asian populations, reduce reliance on imports, and provide season-long fresh high-quality produce. A multi-location study was conducted in fall of 2018 to evaluate 9 Asian vegetable crops to determine their suitability and yield potential. Results of trials in south Texas (Weslaco, TX) and northeast Texas (Overton, TX) are presented only. In Weslaco, a field trial was initiated on Oct. 5, 2018 and harvested 44 days after seeding (DAS) on Dec. 19. Plots were 10 ft long with 2 lines for a total of 40 plants per plot. Plants were fertilized as needed. Quantitative and qualitative data was collected including yield, SPAD, shoot and root fresh and dry weight, and leaf area. In Overton, a field trial was planted on Oct. 5 and harvest on Nov. 16 (60 DAS). A second field trial was planted on Nov. 6 and harvested on Feb. 8, 2019 (138 DAS). A third trial was conducted in a high tunnel and was planted on Nov.

3 and harvested on Dec. 14 (62 DAS). Plot lengths varied among the 3 Overton trials and consisted of 28, 24, and 16 plants/plot, respectively. Yields in Weslaco ranged from a high of 100 Mt/ha for 'White Stem Pak Choi #56' to a low of 22 Mt/ha for 'Baby Leaf Mustard #445', while in Overton, the same crops yielded 15.6 and 6.4 Mt/ha, respectively. The only variety that performed better in the late fall planting than the high tunnel was 'Specialty Pak Choi #535' with yields of 1.97 and 1.3 Mt/ha, respectively. Generally, yield in Weslaco far exceeded that of Overton but relative production of the 9 cultivars followed a similar trend between the 2 locations. Late fall planting in Overton is not recommended since yields were very low and it took another 78 days for the crop to mature for harvest. High tunnel production is a suitable alternative for late fall planting in Overton with similar harvest timing as the early fall planting of 60 DAS.

Specified Source(s) of Funding: Texas A&M Vegetable Strategic Initiative

Effects of Low Air Temperature and Light Intensity after Transplanting on Growth and Yield of Hot Pepper *(Poster Board #129)*

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Hot pepper is a typical warm crop that can retard growth under low temperature and light intensity conditions, and reduced production can be occurred. Recently, there are frequent phenomena that are extreme weather in low temperatures and light intensity in springtime after hot pepper transplanting in open field or a greenhouse. This research objective was to evaluate the effects of low temperature and light intensity on the growth and yield of hot pepper. The treatments were set to two levels of air temperature (ventilation set points 20 and 15^{o}C, respectively) and three levels of light intensity (at zero, 30 and 60% shading ratio), respectively, in the plastic tunnel house, and the transplanting data was made approximately one week ahead of the conventional practice at the end of April and early May. After seven days of low temperature and light intensity treatments, we measured the plant height, length to branch, leaf area, fresh and dry weight of hot pepper, and compared the growth and yield of hot pepper about four months after its application. There was no difference between the plant height, length to branch, and leaf area of seven days after the low temperature and light treatments (initial stage), however the photosynthetic rate was reduced by low air temperature and light intensity (data not shown). After four months treatments, the plant height of hot pepper with control showed 175.4 cm/plant which was the greatest among all the tested treatments, while the fresh and dry weight was the highest 2206.9 and 580.9g/plant, respectively, at 30% shading and low temperature treatment conditions. In addition, the total fresh and dry weight of hot pepper with 30% shading and low air temperature treatments were greatest. The effect of early cold and low light treatments was almost extinguished on hot pepper's growth and yield. Results indicated that the early growth after transplanting can affect by light shading ratio and hot pepper growth might be cope with extreme weather throughout the proper cultural practices during growing period.

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Do Phenolic Compounds Play a Role in the Reduction of Phytophthora Blight Caused By *Phytophthora Capsici* in Jalapeño Pepper? *(Poster Board #130)*

Srijana Dura[*1]; Phillip Lujan[2]; Ivette Guzman[2]; Soum Sanogo[2] and Robert Steiner[2], (1)NMSU, (2)New Mexico State University

Phytophthora blight caused by *Phytophthora capsici* is an economically important and yield-reducing disease in chile pepper and other fruiting vegetables. Chemical, cultural, and exclusion methods, have been used as control strategies, but no single method provides complete and satisfactory results. Therefore, additional measures are needed. It has been observed previously that Phytophthora blight develops slower in Jalapeño cultivars than in other chile pepper types. This research aims at identifying the factors associated with the reduction of Phytophthora blight in Jalapeño cultivars. One possible factor could be an increase in the production of phenolic compounds, which are secondary metabolites involved in plant defense mechanisms against plant pathogens. Six Jalapeño genotypes and two non- Jalapeño genotypes were either inoculated or not inoculated with *P. capsici*. Phenolic compounds were extracted through the Folin-Ciocalteu reagent method and total phenolics were measured spectrophotometrically at two time periods, 12 and 24 hours post-inoculation. Analysis of variance showed no significant 2-way and 3-way interactions among inoculations, genotypes, and time periods. There was a significant difference between inoculation levels and among genotypes, but there was no significant difference between time periods at P-value 0.05. The results showed that the total phenolic content was higher in inoculated plants than non-inoculated plants. Higher phenolic content was observed at 12 hours post-inoculation for all cultivars except for NuMex Pumpkin Spice and NuMex Jalmundo. There was a decline in total phenolic content for Early Jalapeño and NM 6-4 at 24 hours post-inoculation. An increase in phenolic compounds at 12 hours post-inoculation for NM 6-4 was reaction against infection. For NuMex Pumpkin Spice, the lower disease severity may be due to continuous increase in total phenolic content even after 24 hours post-inoculation. However, the lower disease severity in TAM Jalapeño and NuMex Vaquero could be due to the transcription of resistance genes such as CaRGA2 or CaPTI1 because they had similar phenolic content trend as CM-334, which is a resistant genotype to *P. capsici*. Future work will focus on evaluating the concentration of total phenolic content at earlier stages of post-inoculation (3 and 6 hours) and on analyzing the expression of resistance genes.

Specified Source(s) of Funding: NM Ag Expt Station and NM Chile Association

Weed Control & Pest Management 2 (Poster)

Efficacy of Soil Fumigants on Southern Root-Knot Nematode and Yield of Carrot *(Poster Board #097)*

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The southern root-knot nematode, *Meoidogyne incognita*, is a major constraint to the carrot production. Preplant soil fumigation is an important approach to manage the nematode in double-cropping systems. On a commercial vegetable farm near Statesboro in the southeastern part of Georgia, Telone II (1,3- dichloropropene), Pic-Chlor 80 [1,3- dichloropropene (20%) and chloropicrin (80%)] and Pic-Chlor 100 [chloropicrin (100%)] were applied to a field naturally infested with *M. incognita*. Treatments were assigned to 300 m long, three-bed plots (0.2 m tall, 1.5 m bed top width), which were arranged in a randomized complete block design with three replicates. Broadcast applications of Telone II (112 L/ha) were made with a Harrell six-bottom switch plow with knives spaced 0.5 m apart delivering fumigant at a depth of 0.3 m in non-bedded soil. Beds were then formed with a Kennco three-row bed shaper and the center bed was used only in this work. Pic-Chlor 80 (112 and 168 kg/ha) and Pic-Chlor 100 (112 and 168 kg/ha) were applied with a tractor through subsurface knives (5 knives placed 0.3 m deep) during bed formation. Fumigant applications were made 4 weeks before carrot seeding into the area. A control block with no chemical application was included, and both treated and untreated blocks were monitored for nematode infection. Carrot samples containing taproots and fibrous roots, and soil samples were taken at harvest on 11 Jun. 2018 to examine the nematode reproduction and yield losses. Pre-plant soil fumigation with Telone II and Pic-Chlor did not completely affect root-knot nematode populations allowing the nematode to develop and damage carrot during the growing season. Carrot plants in the fumigant-treated plots had significantly ($P < 0.05$) lower nematode numbers, gall rating and root rating than the untreated control. Plots treated with Telone II had often numerically reduced nematode numbers and gall and root ratings compared to the plots treated with Pic-Chlor. Total carrot yield was not significantly different between treated and not-treated plots, however, total yield in the plots treated with Pic-Chlor 80 (112 kg/ha) and Pic-Chlor 100 (112 kg/ha) were numerically higher than that of the Telone II treatment.

Effects of Hawaii's Coffee Berry Borer IPM Program *(Poster Board #098)*

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Since 2013, research and outreach has been conducted in Hawaii on managing Coffee Berry Borer (CBB), *Hypothenemus hampei* (Ferrari). CBB integrated pest management (IPM) recommendations were developed for Hawaii coffee growers and modified as new information was discovered. Outreach of these technologies included workshops, field days, Extension publications, and videos. Grower surveys from 2012 to 2018 show positive impacts over time, resulting from the adoption and understanding of Hawaii's CBB IPM program and indicate high adoption for the most important aspects of CBB control including field sanitation and especially timely strip picking, sampling and monitoring, and *Beauveria bassiana* sprays. Other industry responses to the introduction of CBB include purchasing cherry using a sliding scale price based on CBB damage, an interisland quarantine of green coffee and any coffee related materials, and the perceived need to increase yields to offset production costs. Education efforts and quarantine regulations have slowed the spread to other islands and farms. Those implementing CBB IPM recommendations and selling cherry to processors, received top dollar per pound of coffee. As a result of CBB, cherry and estate farmers are also learning of other threats to production, including the coffee root-knot nematode.

Specified Source(s) of Funding: USDA, UH CTAHR, HDOA, County of Maui, County of Hawaii

Screening for Actinomycete Producers of Novel Anti-Anthracnose Compounds *(Poster Board #099)*

Lorenzo Bizzio*; Doug Phillips; Philip Harmon and Patricio Munoz, University of Florida

Anthracnose fruit rot (*Colletotrichum gloeosporioides*) is a particularly devastating fungal disease of many fruit crops that causes millions of dollars in damage every year. Current methods of anthracnose control are heavily reliant on the thorough application of several fungicides. There is great concern over the continued use of current anti-anthracnose compounds due to the appearance of numerous fungicide-resistant strains. Examples abound of instances where overapplication of conventional fungicides led to the rapid emergence of highly resistant anthracnose variants against which growers had no defense- as the case of the blueberry variety 'Flicker' in Florida demonstrates. The development of novel anti-anthracnose fungicidal compounds is one way to combat the rise of new anthracnose strains displaying resistance to currently used fungicides. To aid in the search for such compounds, we examined the potential of actinomycete strains from Florida's unique sand pine scrub ecoregion to produce anti-anthracnose natural compounds. Preliminary screening of over 300 isolates revealed several with activity against an aggressive strain of anthracnose fruit rot. This activity manifested itself as inhibiting the germination of *C. gloeosporioides* conidia, halting the spread of *C. gloeosporioides* mycelia, or doing both. Further research going forward includes isolating the fungicidal compounds of interest from the producing strains and testing them for toxicity against humans and the environment.

Specified Source(s) of Funding: University of Florida Blueberry Breeding and Genomics Lab

Effect of Plastic Mulch Color on Aphid Populations and Virus Incidence in Summer Squash *(Poster Board #102)*

Rachel Rudolph*; Emily Pfeufer and Ricardo Bessin, University of Kentucky

Although the central Kentucky climate and growing conditions lend themselves to high quality summer squash (*Cucurbita pepo* L.) production, there are several prominent pests that can lead to significant yield losses. One pest Kentucky growers are concerned with is aphids (Family Aphidae), which are known to develop high populations during the summer as well as transmit viruses to cucurbit plants. Alate and apterous aphids are vectors for zucchini yellow mosaic virus (ZYMV). Standard cucurbit production practices include black plastic mulch accompanied by intensive insecticide or row cover use. In August 2018, 'Multipik' summer squash was grown in an open field on four different colors of plastic mulch—black, white, silver, and red. The objective of the study was to evaluate the effects of plastic mulch color on insect pest presence and movement as well as the diseases they can transmit. Two and three weeks after sowing, fewer alate aphids were trapped in silver mulch plots than in any of the other mulches except in week two where the aphid count in the silver mulch was not significantly different from the white mulch. In week two, the white mulch had significantly fewer alate aphids than in the red mulch and in week three the white mulch had fewer trapped aphids than in the black mulch plots. Three weeks after sowing, ZYMV was unexpectedly confirmed in all five experimental replicates. Four weeks after seeding, significantly more squash plants growing in red mulch (19%) were symptomatic for ZYMV, compared to the silver (1%) and white (2%) mulched plants. No statistically significant differences were apparent at two subsequent weekly counts, though squash in the silver mulch showed the lowest numerical ZYMV incidence. There were no significant yield differences among treatments. This study is being repeated in 2019.

Rose Rosette Virus: Exploration of Potential Root Transmission *(Poster Board #103)*

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Landscape rose production is a $200 million dollar/year industry in the United States. Roses, like other landscape ornamentals, are typically grown in production fields with close spacing (6-12 inches) to allow for the maximum amount of plants in an area. While this close planting situation is ideal for mass production, it can allow for the rapid spread of diseases in production fields. One disease that is troubling rose growers in much of the country is Rose Rosette Disease (RRD). This disease is a viral disease caused by *Rose rosette virus* (RRV), which has a primary mode of plant to plant transmission through an arthropod vector, *Phyllocoptes fructiphilus,* an eriophyid mite. However, research has shown that there are other modes of transmission for RRV, such as grafting. Another mode of RRV transmission that has been suggested since the 1950's is the movement of the virus through root contact or root grafting. Root transmission has been demonstrated in roses using other viral diseases. After the discovery of RRV in rose production fields in 2016-2017, there were questions of potential root transmission. Our study utilized 100 plants from this production field: 10 sets of 10 adjacent plants. Each set contained five plants (spaced at 7, 14, 21, 28 and 35 inches) radiating from a RRV positive plant. These plants were harvested from the field, prepared as bare rooted transplants, and were potted in individual pots and monitored over a one year period. Plants were regularly monitored for mites and preventative miticide applications were used. No mites were found during the experiment. Of 100 plants, 17 developed RRD symptoms and had positive PCR tests within six months. At the termination of this study, RRV was detected via PCR in 56 additional asymptomatic plants, suggesting that plants may have been infected prior to harvest. Many positive plants were 35 inches from the initial plant, leading us to question the RRV transmission method. Natural mite distribution is random in a field, so it is unlikely that mites were evenly disbursed. Also, field data collected suggests that eriophyid mite populations were aggressively managed, suggesting the possibility of alternate transmission types. We are exploring root transmission of RRV; understanding all modes of RRV transmission will allow producers to make more informed decisions in developing production planting designs. Such information may also provide guidance to how many adjacent plants should be rogued when an infected plant is discovered.

Characterizing Spray Penetration of a Novel Sprayer into *Malus Domestica* 'Golden Delicious' Apple Trees at a Commercial Orchard *(Poster Board #104)*

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Variable-rate spray technology that applies pesticides based on real-time scanning laser rangefinder measurements of plant presence, size, and density was developed and retrofitted to existing sprayers. The objective of this experiment was to characterize spray application at four rates when applied to *Malus domestica* 'Golden Delicious' apple trees using this technology.

Four pairs of uniform trees were selected, and four clips for water sensitive cards (WSCs) were placed equidistant from one another within each canopy at increasing distances from the driveway and approximately 175 cm from the ground. A fifth card was placed below card 1 to detect non-target spray to the orchard floor. One of four rates, 0.03, 0.05, 0.07, or 0.09 fl oz/ft^3, was randomly assigned to each pair of trees within the row so that all four rates were tested on each run. WSCs were placed in the clips, and the trees were sprayed with water. Rates were randomly re-assigned to trees, and a WSC was placed in each clip prior to each of the three subsequent runs. Cards were collected and analyzed using DepositScan software. Then, the sprayer was operated at each rate in the same random order as previously to spray cards, and volume was recorded. Each rate was repeated three times. There was no year effect so data were pooled.

Coverage and deposit density were affected by rate (*P*-value <0.0004, or lower) and card position (*P*-value <0.0001). Coverage decreased with increasing distance from the sprayer. Coverage decreased between cards 1 and 2, 2 and 3, and 3 and 4, 12%, 14%, and 22%, respectively. Non-target coverage on card 5 (Southern row) exceeded 20% at the two highest rates.

Deposit density was lowest for the cards closest to the driveway (cards 1 and 2) at the two highest rates due to coalescence. Densities at each rate met or exceeded the recommended thresholds (insecticides 20-30 droplets/cm^2; fungicides 50-70 droplet/cm^2).

Spray volume correlated with rate (R^2=0.9999). Volume applied from each spray rate differed from one another (*P*-value <0.0001 for each comparison) and ranged from 5.9 gallons (0.03 fl oz/ft^3) to 14.4 gallons (0.09 fl oz/ft^3).

On average, the lowest rate reduced non-target, orchard floor pesticide coverage by 81% compared to the highest rate in the study. Applying 0.03 fl oz/ft^3 with a dynamic laser-based sprayer achieved or exceeded deposit density efficacy levels and would reduce spray volume 84% per acre compared with the tree row volume method and 72% compared to the grower's standard application of 125 gal/acre.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant

Development of Integrated Approaches for Managing Fusarium Wilt of Watermelon *(Poster Board #105)*

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Fusarium wilt of watermelon, caused by the fungal pathogen *Fusarium oxysporum* f. sp. *niveum* (FON), is responsible for significant yield loss in watermelon production in Georgia. The disease is also well established in nearly all watermelon growing regions in the United States and the world. In Georgia, the disease causes increasing damage in watermelon production in recent years. Management of Fusarium wilt of watermelon is challenging due to long-term survival of the pathogen in the soil, lack of resistant watermelon cultivars to aggressive races of the pathogen, and limited availability of effective fungicides. In this study, chemical fungicides, biological control agents, and systemic acquired resistance (SAR) inducers were evaluated to develop integrated programs for managing this disease. A number of chemical fungicides and different application methods were evaluated in repeated field experiments in Tifton, Georgia, USA. Two applications of pydiflumetofen through drip irrigation tubes, or drip application of pydiflumetofen at transplanting followed by directed spray of the fungicide two weeks after transplanting, were among the most effective in disease reduction. Directed spray of pydiflumetofen prior to transplanting targeting the area in the field plot for transplanting also reduced disease significantly compared to the nontreated control. Biological control agents, including species of *Bacillus* and *Pseudomonas*, were evaluated. The biocontrol agents showed a tendency to enhance disease reduction when applied in conjunction with pydiflumetofen or prothioconazole. Integrated applications of pydiflumetofen with the SAR inducer acibenzolar-*S*-methyl or prothioconazole consistently reduced disease significantly and were among the most effective treatments. Results of the study provide valuable information and viable options for managing this destructive disease impacting watermelon production.

Specified Source(s) of Funding: USDA-NIFA SCRI Program

Application of Antibacterial Lactic Acid Bacteria Isolated from Korean Traditional Products *(Poster Board #106)*

Kwang-Yeol Yang*, Chonnam National University

Application of Antibacterial Lactic Acid Bacteria Isolated from Korean Traditional Products

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A total 110 isolates of lactic acid bacteria were isolated from

Korean traditional fermented products such as kimchi, soybean paste, red pepper paste and soy sauce. These bacteria were identified as *Lactobacillus sakei*, *Lactobacillus plantarum* and *Weissella Hellenica* on the basis of morphological and 16s rDNA sequence analysis. Out of 110 isolates tested, only 18 isolates exhibited antimicrobial activity against pathogenic bacteria such as *Pseudomonas aeruginosa* (KCTC2513) and *Bacillus thuringiensis* (KCTC1507). Among them, the strain KC68 isolated from Kimchi showed the strongest antibacterial activity against both pathogenic bacteria. The strain KC68 was identified as *Lactobacillus sakei* and named *Lactobacillus sakei* JNU68. The antimicrobial activity of *Lactobacillus sakei* JNU68 was stable in sterilized supernatant at 100℃ for 15min, but the activity was lost in the supernatant after adjusting pH 7. Optimal temperature for the growth of *Lactobacillus sakei* JNU68 was significantly better at 37℃ than at 30℃ and the stationary phase was reached after 18 h of inoculation. The *Lactobacillus sakei* JNU68 was also cultivated in rice flour and then tested for antimicrobial activity, and the results showed that it was reproduced as shown in the MRS medium. These results suggested that *Lactobacillus sakei* JNU68 isolated from Korean traditional fermented products has good potential in extending the shelf-life of rice cakes.

This study was financially supported by the IPET through High Value-added Food Technology Development Program, funded by Ministry for Agriculture, Food and Rural Affairs, Republic of Korea.

Keyword: Lactic Acid Bacteria, Traditional Fermented Products, *Lactobacillus sakei*, Rice flour

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Effect of Calcium Chloride Spray on Powdery Mildew in Hydroponically Grown Lettuce *(Poster Board #107)*

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Hydroponically-grown leafy green production is a fast-growing area in the greenhouse industry that allows year-round access to fresh, local produce. Powdery mildew is a fungal disease, which harms a wide variety of plants including hydroponic crops. The disease is prevalent in environments with dense foliage, restricted airflow, high humidity, and moderate temperatures which are common conditions in greenhouse crops including lettuce. Growers currently experience significant crop loss and yield reductions in hydroponic lettuce due to powdery mildew. Application of calcium chloride ($CaCl_2$) has been reported to control other fungal diseases like grey mold. We investigated the efficacy of calcium chloride in controlling powdery mildew disease on hydroponically grown lettuce cultivar **(***Lactuca sativa* 'Salanova® Green Butter'**)** known to be susceptible to powdery mildew. The first experiment was conducted in a high humidity growth chamber with plants treated with either 0 or 800 $mg \cdot L^{-1}$ $CaCl_2$ twice a week. The average number of infected leaves per plant was seven in the 800 $mg \cdot L^{-1}$ treatment as compared to 23 in the control. The second experiment was conducted in the greenhouse and the plants were treated with either 0 $mg \cdot L^{-1}$ or 800 $mg \cdot L^{-1}$, either lab-grade or commercial-grade. The average number of infected leaves per plant was eight and six following application of lab grade and commercial grade $CaCl_2$ as compared to control with twenty leaves. A 60 g reduction in yield was noted following application of lab grade $CaCl_2$. Foliar sprays of $CaCl_2$ reduced powdery mildew disease severity in hydroponically grown lettuce 'Green Butter'. Calcium chloride is readily available to growers and will provide a viable alternative to fungicides for the control of powdery mildew on hydroponic lettuce.

Part 4: Index of Authors

INDEX OF AUTHORS

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