

**Abstracts of Presentations**  
from the  
**Annual Conference**  
of the  
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Contains abstracts of symposia, colloquia, workshops, plus oral and poster presentations from the 2010 ASHS Annual Conference.

Author index begins on p. S316

For citation purposes, abstracts should be cited as follows:

(Example)

Nesmith, W.C. and W.M. Dowler. 2010. Cold hardiness of peach trees as affected by certain cultural practices. *HortScience* 45(8):S234. (Abstr.)

Monday, August 2, 2010 8:00 am–12:00 pm

Springs K & L

## Industry Forum: Drip and Micro Irrigation Technology

Sponsor: ASHS Industry Division

Coordinator: Neal E. De Vos, [ndevos@got.net](mailto:ndevos@got.net)

The symposium is structured as a series of presentations from five pairs of companies that use contrasting technologies to assist growers with five key aspects of irrigation: 1) drip irrigation (drip tape, drip hose, surface/subsurface irrigation, retrieval methods, pressure-compensating/non-pressure-compensating emitters, tape wall thickness), 2) micro irrigation (micro sprinklers, advantages/disadvantages vs. drip, agricultural/nursery applications, flow rates, spray patterns), 3) filtration (sand media filters, screen filters, backflushing, filtration requirements for drip and micro irrigation), 4) chemical/fertilizer injection (discussion/demonstration of available devices, maintaining concentration with varying flow rates), and 5) soil monitoring (devices/methods and communication systems to obtain soil moisture, electrical conductivity, and temperature information). Speakers will provide information about their company's specific products as well as general descriptions about the irrigation industry. Each presentation will be followed by discussion based on questions from the audience.

8:00–8:15 am

### Introduction to the Symposium

\*Franklin P. Gaudi

8:15–9:00 am

### Drip Irrigation

John Deere Water (San Marcos, CA) and Netafim USA (Fresno, CA)

9:00–9:45 am

### Micro Irrigation

Olson Irrigation Systems (Santee, CA) and The Toro Company (Riverside, CA)

9:45–10:30 am

### Filtration

Amiad Filtration Systems (Oxnard, CA) and Yardney Water Management Systems, Inc. (Riverside, CA)

10:30–11:15 am

### Injection

Netafim USA (Fresno, CA) and Ozawa R&D Inc., Advanced Water Products (Kerman, CA)

11:15 am–12:00 pm

### Soil Monitoring

E.S.I. Environmental Sensors Inc. (Sidney, BC, Canada) and PureSense Environmental, Inc. (Fresno, CA)

Tuesday, August 3 8:00 am–6:00 pm

Desert Salon 1-3

## Current Issues and Applications for Intellectual Property of Horticultural Plant Cultivars

Sponsor: ASHS Industry Division

Moderator: Larry D. Knerr, Shamrock Seed Company, Salinas, CA

A distinguished group of speakers will update and inform on the present, and possible future, complexities of protecting horticultural intellectual property in the U.S. and abroad. Topics will cover both asexually and sexually propagated crops. Included will be an in-depth panel discussion at the conclusion of the formal presentations.

8:00-8:05 am

### Introduction to Symposium/Moderator

Larry D. Knerr

Shamrock Seed Company, Salinas, CA 93901

8:05-8:55 am

### Basics of Intellectual Property Rights for Plants

Robert J. Jondle, JD

Jondle & Associates, P.C., Castle Rock, CO 80108

Plant research can often result in new plant inventions, for example new methods, improved trait levels, mutations and varieties. Learn about options for U.S. and worldwide plant protection. We will discuss utility patents, U.S. plant patents, Plant Breeder's Rights, Community Plant Breeder's Rights, U.S. PVP, licenses, written agreements, material transfer agreements, restrictive use agreements, trademarks and trade secrets. Also we will discuss the important issues of freedom to operate and legal access and ownership of plant materials.

#### *About the presenter:*

Robert Jondle is a patent and trademark attorney who specializes in worldwide plant protection and plant intellectual property rights. He earned a PhD in Plant Breeding and Genetics from Iowa State University and received a Law degree from Georgetown University Law School. He is a member of the District of Columbia, Maryland and Colorado Bar Associations; the American Bar Association, the American Intellectual Property Law Association, the Federal Circuit Bar Association and the U.S. Supreme Court Bar Association.

After graduating from Iowa State, Jondle worked for 14 years in the plant industry as a researcher, Research Director and then as Vice President of Research. In 1987, he joined a Washington, D.C. patent law firm and he has been working in plant intellectual property rights for the last 23 years. In 2002 Bob started the law firm of Jondle & Associates, P.C., in the Denver, Colorado area and nearly 100% of the firm's legal work is with

plants and plant protection, including patents, Plant Breeder's Rights, trademarks, and licensing.

Jondle is the author of numerous articles and has frequently lectured in the area of intellectual property protection for plants. Dr. Jondle has been Chair of the Plant Committee in the Biosciences Division of the American Bar Association's Intellectual Property Law Section, Chair of the American Seed Trade Association, and past Chair and steering committee member of the Intellectual Property Rights Working Group of the American Society for Horticultural Science. He frequently has been an invited speaker on biotechnology and plant proprietary rights issues.

8:55–9:45 am

### Pitfalls in Protecting the Seed of Invention in Plant Patents

Tambryn K. VanHeyningen, JD

Andrus, Sceaux, Starke & Sawall, LLP, Milwaukee, WI 53202

Prior to filing a plant patent application the applicant must avoid several pitfalls or risk losing the rights to the plant patent. Among the two most common pitfalls to snare inventors are: 1) correctly identifying all the inventors of the plant and 2) avoiding public disclosure of the plant. Inventorship of a plant patent and the analysis required is quite distinct from that of a utility patent. The inventor is not simply the person who discovers or cultivates a seedling. Instead, the inventor must (1) identify the distinct characteristics of the plant and (2) asexually reproduce it. These two aspects may be separable and determining who to include as an inventor will be discussed. In addition, a public disclosure of the plant more than one year prior to filing a plant patent application may bar patentability. A public disclosure occurs when making and/or using an invention is made available to the public in writing, orally, by use in public, or by an offer to sell or sale of the plant. Determining whether a public disclosure has occurred requires analyzing whether a person having ordinary skill in the art would be able to practice the invention based on

the disclosure. The difficulties of determining what constitutes a public disclosure of a plant will be discussed.

*About the presenter:*

Tambryn VanHeyningen is a patent attorney with Andrus, Scales, Starke & Sawall, LLP in Milwaukee, Wisconsin. She received her JD from Washington University School of Law and earned a PhD in Microbiology from Washington University School of Medicine. VanHeyningen's practice focuses on protecting intellectual property assets, including patent procurement, enforcement, licensing, due diligence and trade secret protection. Her experience includes drafting and prosecuting patents with an emphasis in life sciences, chemistry and biotechnology, including asexually reproduced plants, genetically engineered organisms, microbiology, molecular biology, and agricultural products. VanHeyningen has experience drafting patentability, freedom-to-operate, patent non-infringement and patent invalidity opinions. She also has experience negotiating and drafting license agreements. Her clients include University technology transfer entities, research institutions, small start-up, and large privately held biotechnology companies.

9:45–10:00 am

**Break**

10:00–10:50 am

**Trademarking Intellectual Property**

John D. Rodriguez, JD

U.S. Patent and Trademark Office, Alexandria, VA 22314

This presentation will provide information on how businesses should proceed in successfully identifying, selecting and maintaining a trademark for their goods and services. Among the topics that will be covered include: tips to keep in mind when selecting a trademark for your goods or services, types of trademark protection in the United States, the process of applying for a trademark registration at the United States Patent and Trademark Office with specific focus on trademark applications for seeds and plants, how to seek trademark protection internationally, and, finally, how to properly maintain your trademark registration (including tips on how your mark can avoid becoming a victim of “genericide”). In summary, participants should gain a better understanding of how to take advantage of the U.S. trademark system in order to identify and distinguish their products in the marketplace.

*About the presenter:*

John Rodriguez is an Attorney-Advisor with the Office of External Affairs at the United States Patent and Trademark Office (USPTO). He focuses on trademarks and geographical indications matters across a variety of regions, but has a special emphasis on Central America and South America. Rodriguez has served as a member of the U.S. delegation team

on several free trade agreement negotiations as well as on discussions regarding FTA implementation and compliance. In addition, he has represented the United States to the Standing Committee on the Law of Trademarks, Industrial Designs and Geographical Indications at the World Intellectual Property Organization in Geneva, Switzerland. Rodriguez has also taken part in numerous country reviews of intellectual property legislation as part of the WTO Accession process. He has been a frequent lecturer at the USPTO's Global Intellectual Property Academy (GIPA) where foreign intellectual property officials are trained and at the USPTO's outreach events to small and medium size enterprises known as Intellectual Property Awareness Campaign (IPAC) where he has addressed trademark protection in the United States and trademark protection internationally.

Rodriguez began his tenure at the USPTO as a Trademark Examining Attorney where he examined trademark applications submitted for registration in compliance with the Lanham Act, the Trademark Rules of Procedure, and the Trademark Manual of Examining Procedure. He also prepared ex parte appeal briefs for consideration by the Trademark Trial and Appeal Board.

Education: Rhodes College—Bachelor of Arts in International Relations, 1996; Cumberland School of Law—Juris Doctorate, 1999.

10:50–11:40

**Licensing Agreements and Commercialization Strategies**

Joel E. Cape, JD

Frilot, LLC, New Orleans, LA 70163

The intellectual property license must address fundamental issues that account for risks and ensure the IP is preserved. Beyond addressing the basics, the IP license plays an important role in an effective commercialization strategy. Leveraging IP through licensing requires identifying goals and a critical analysis of the business environment. The expectations of the business side must be balanced against legal rights and risks. Finally, licensing and commercialization of IP in plant materials involves unique considerations inherent in its place in agriculture.

*About the presenter:*

Joel Cape is a member of the New Orleans law firm Frilot LLC. He has a broad practice ranging from litigation representation to transactional counseling in local, state, and national forums. He has a particular focus on agriculture and agribusiness where he represents clients in complex commercial litigation, agricultural products liability, intellectual property protection, farmland leasing, agricultural production, and agricultural contracts. Joel also counsels clients on product labeling and marketing, regulatory compliance, and various farm programs.

Since beginning his practice, Joel has concentrated on the agricultural sector and many of his clients are agricultural producers and agribusinesses. This focus is the result of his genuine

experience in agriculture - from working on his family's farm, to participating in 4-H and FFA, to his college and law school education. Joel earned his undergraduate degree in agricultural economics from Oklahoma State University, and a Master of Laws degree in Agricultural Law from the University of Arkansas School of Law. He is also a member of the American Agricultural Law Association.

11:40 am–1:00 pm

### Lunch

1:00–1:50 pm

### Current Issues in the International Licensing of Plant Varieties

Patrick H. Ballew, JD

Patrick H Ballew, Inc., P.S., Ballew Law; Yakima, WA 98902

This presentation will primarily discuss the development and implementation of the Pier-To-Pier™ licensing system as a solution to many problems that arise in the international licensing and trade of plant varieties and commercial fruit.

#### *About the presenter:*

Patrick H. Ballew, of Ballew Law in Yakima, Washington, has over 20 years of experience in the international registration, licensing, and litigation of plant varieties, and in the administration of internationally traded commercial fruit varieties.

1:50–2:40 pm

### Positive Impacts of Intellectual Property on Public Breeding Program Support

John R. Clark

Department of Horticulture, University of Arkansas, Fayetteville, AR 72701

Public plant breeding programs have been the basis for crop advancement for most crops in the United States and world. Although private breeding efforts have replaced public programs for many major row crops along with numerous vegetable species, public programs continue to be important for many fruit crops as well as more minor vegetables and various other species. Financial support for public breeding programs has been subject to severe pressures in recent years. Where substantial local industry support for a program has not been present, alternative avenues of generating revenue have been closely examined. Or, if no local industry revenue has been forthcoming, the termination of the public effort has often resulted. Intellectual property offers one avenue to generate revenue. The most common source has been in cultivar royalties, paid by companies that propagate the crop species. Royalties are then used, at least to some degree, to fund breeding program activities. Other avenues of potential

value are testing of breeding selections from a program. This type of agreement usually involves payment for testing rights of released cultivars or unreleased selections in a specific territory, and can also include exclusive commercialization rights. Subsequent royalty income from commercialization of selections (and possibly from genotypes that are not released formally from the program or otherwise discarded) usually follows. Breeding agreements involve a more developed arrangement, where a private entity uses genetic products such as gametes or seeds from the public program, and a fee is paid to access the material. The resulting seedlings are usually evaluated at the site of commercial production of the private entity. This arrangement allows the full genotype × environment interaction to take place, potentially maximizing the genetic potential of the breeding material. Subsequent commercial products then generate royalties. These approaches, along with other innovative ideas, allow intellectual property rights to be a major asset in program support and in continuation of breeding efforts. Examples of these agreements and further success stories of intellectual property support will be discussed.

#### *About the presenter:*

John R. Clark is a professor of horticulture at the University of Arkansas. His research responsibilities are his primary appointment, where he directs the University's Division of Agriculture fruit breeding program and manages the intellectual property rights of the program's developments. Crops he works with include blackberries, table grapes, muscadine grapes, blueberries, and peaches/nectarines. Clark also teaches plant breeding and fruit production and advises graduate and undergraduate students. In the past decade he has emphasized intellectual property rights as a key source of program support for the University's fruit breeding program, including a blend of agreements such as licensing, selection testing, and breeding with a range of nurseries and fruit companies in the U.S. and across the world.

2:40–2:55 pm

### Break

2:55–3:45 pm

### IP Licensing at Public Institutions: Meeting Stakeholder Expectations?

John C. Beuttenmuller

Florida Foundation Seed Producers, Florida Agricultural Experiment Station, Gainesville, FL 32611

In a climate of budget shortfalls at both the state and federal levels, land grant Universities are scrambling to find ways to support their plant breeding programs. Given the long-term nature of these programs, it's often hard to show legislators and stakeholders an immediate return on investments which are made in public plant breeding programs. Many agricultural industries in the United States, however, understand that con-

tinued plant breeding is vital to their long-term survivability and success.

The Bayh-Dole Act, enacted by the U.S. Congress in 1980, allowed Universities to own and control intellectual property created through federally funded research. Since the inception of this Act, there has been an extraordinary shift in how land-grant Universities make new plant varieties available to industry. Many new plant varieties are now protected domestically under U.S. utility patents, plant patents, or plant variety protection certificates (PVPs). Royalties generated through the licensing of plant varieties released from land grant Universities have been vital to the recent success of many public plant breeding programs. Furthermore, as public funding for plant breeding programs dwindles, the survivability of these long-term research programs has often times become dependent on program royalties.

Nonetheless, however, the process of licensing protected plant varieties released from land grant Universities has been the origin of much debate. How does the patenting and licensing of plant varieties released from land grant Universities fit in with the proverbial “land grant mission”? How are breeding programs at land grant Universities meeting the increasing needs, demands, and expectations of the agricultural industries in their own states? Are stakeholder expectations best met via exclusive licenses, non-exclusive licenses, or public release?

*About the presenter:*

John C. Beuttenmuller is the Germplasm Manger for the Florida Agricultural Experiment Station (FAES) and the Intellectual Property and Licensing Director for Florida Foundation Seed Producers, Inc. (FFSP), a non-profit corporation and direct support organization of the University of Florida. John is responsible for the marketing and licensing of all germplasm discovered and developed in the FAES. John facilitates invention and technology transfer to the agriculture industry and manages all forms of intellectual property protection relating to new plant varieties. In his role with FFSP, John negotiates and manages license agreements for 45 different crops which are licensed in territories worldwide.

3:45–4:35 pm

**Evolution and Future of Global Agricultural IP**

David Brazelton

Fall Creek Farm & Nursery, Inc., Lowell, OR 97452

Amelie Aust, LL.M.

Fall Creek Farm & Nursery, Inc., Lowell, OR 97452

The last decade has seen immense changes in the role of intellectual property for all levels in the produce industry,

from breeders to nurseries, growers and packers, marketers, and retailers. This has brought about critical shifts not only in core business models, but also in the movement and valuation of produce worldwide. Although different produce types experience similar patterns of boom, bust, and maturation, many are at different stages in their intellectual property evolution, and there are lessons to be learned across crops and geographies that can serve as precursors for the others. This presentation will provide a global perspective on these shifts and changes, as well as a view into what is to come and how to best position and prepare if these patterns and movements persist.

*About the presenters:*

David Brazelton, President and founder of Fall Creek Farm & Nursery, the world’s largest blueberry nursery, has worked in the blueberry industry for over 30 years. Mr. Brazelton has consulted with blueberry companies and growers throughout the world in all aspects of blueberry variety, horticulture, and go-to-market planning. He has more than 15 years of experience in the licensing and commercialization of proprietary blueberry varieties both in the U.S. and countries abroad spanning five continents. He has served the blueberry industry in various capacities as President of the Oregon Blueberry Growers Association, Chairman of the Oregon Blueberry Commission, Western States Representative for the USHBC, and is currently Chairman of the USHBC Research Committee.

Amelie Aust is the New Business Manager at Fall Creek Farm & Nursery, the world’s largest blueberry nursery. There she oversees the R&D breeding programs, Intellectual Property, Product Development, and Marketing. She received a Masters of Law in Intellectual Property at the Max Planck Institute in Munich, Germany, and focused her thesis studies on Trademark Law in the grocery produce section. Mrs. Aust returned to Fall Creek, her family’s business, in Oregon in 2008.

4:35–4:45 pm

**Break**

4:45–6:00 pm

**Panel Questions and Discussion**

Moderator: Amelie Aust, LL.M.; Fall Creek Farm & Nursery, Inc., Lowell, OR 97452

The symposium concludes with an open panel question and discussion session with all of our speakers participating.

**Monday, August 2, 2010 Desert Salon 7**  
**Applications of Next-Generation Sequencing to Horticultural Crops**

**8:00 am–6:00 pm**

Sponsor: Plant Biotechnology

Moderator: Nahla V. Bassil

USDA-ARS, Corvallis, OR; bassiln@hort.oregonstate.edu

In this workshop, we plan to offer an overview of next-generation sequencing technologies and their applications in horticultural crops. Speakers selected for the colloquium will cover three main applications: Genome annotation; gene discovery and transcriptomics; and high throughput fingerprinting.

2:00–2:15 pm

**Applications of Next-Generation Sequencing to Horticultural Crops**

Nahla Bassil\*

USDA-ARS-NCGR, Corvallis, OR; bassiln@hort.oregonstate.edu

New DNA sequencing instruments referred to as “next generation” or “massively parallel” sequencing platforms are becoming widely available and transforming genomic discovery in plants. They deliver an enormous amount of sequence data that require specialized and devoted computer infrastructure and bioinformatics. These technologies will impact many of the current uses of molecular tools in plant evolution, phylogenetics, gene discovery, fingerprinting, linkage mapping, and marker-assisted selection, among others. Use of these next-generation sequencing technologies has begun in vegetable and fruit crops.

2:15–2:35 pm

**Utilization of Next-Generation Sequencing for Analyzing Transgenic Insertions in Plum: A Risk Assessment Study**

Ann Callahan\*

USDA-ARS, Kearneysville, WV; Ann.Callahan@ars.usda.gov

Chris Dardick

USDA-ARS, Kearneysville, WV; chris.dardick@ars.usda.gov

Ralph Scorza

USDA-ARS, Kearneysville, WV; ralph.scorza@ars.usda.gov

When utilizing transgenic plants it is useful to know how many copies of the genes were inserted and the locations of these insertions in the genome. This information can provide impor-

tant insights for the interpretation of transgene expression and the resulting phenotype. Traditionally, these questions were answered with DNA blot analyses for the copy number, and progeny analyses for both the copy number and for physical mapping. Other techniques have been used such as inverted PCR and sequencing of specific fragments of DNA. Next-Generation sequencing presents a powerful tool for transgene insertion analysis. Transgene characterization of ‘HoneySweet’ plum (*Prunus domestica*) had been previously obtained from DNA blot analyses, PCR approaches, small and large fragment sequencing and progeny segregation ratios. We are using ‘HoneySweet’ to compare Next-Generation sequencing with traditional analytical methods already used for the detection of transgene copy number and insertion location in ‘HoneySweet’. We are also incorporating Next-Generation sequencing for marker development and gene identification for use with traditional breeding, genetic engineering and for accelerated ‘FasTrack’ breeding, a method that utilizes transgenic early flowering plums for reducing the generation time.

2:35–2:55 pm

**Tissue and Developmental Transcriptome Differences in Strawberry Revealed with Next-Generation Sequencing**

Kevin Folta\*

University of Florida, Gainesville, FL; kfolta@ifas.ufl.edu

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Transcriptome assessment using next-generation sequence platforms permits large-scale qualitative and quantitative measures of gene expression in various tissues or following specific treatments. Activities in our laboratories have surveyed strawberry (*Fragaria xananassa*) transcripts across wide treatments and

conditions, tissues and developmental timelines. The results not only provide an accounting of strawberry transcripts, they also uncover instances of tissue-specific expression. Transcripts specific to developing fruit have been identified and include a suite of transcripts with known roles in flavor and firmness. A large set of hypothetical proteins has been uncovered and are being functionally evaluated in transgenic systems. Unintended consequences of the study have identified transcripts expressed at high levels in all tissues, making them useful reference genes for expression analyses. Potential pests and pathogens were also revealed from next generation sequencing. This study uses massive transcriptome sequencing as a stepping-off point to in planta functional evaluation and high resolution studies of gene expression regarding traits of horticultural interest.

2:55–3:15 pm

### Transcriptome Analysis of Cucumber Fruit Development Using Next-Generation Sequencing Technologies

Rebecca Grumet\*

Michigan State University, East Lansing, MI; grumet@msu.edu

Cucumber (*Cucumis sativus* L.) fruit undergo a typical sigmoidal pattern of growth during early stages of development. The first few days (0–4 dpp) are dominated by cell division, followed by a period of rapid expansion (4–12 dpp) that slows as near full size is reached at 12–16 dpp. Massively parallel 454 pyrosequencing analysis was used to study changes in gene expression during these early stages of cucumber fruit growth. Expression libraries were prepared from fruits at 0, 4, 8, 12, and 16 dpp, yielding approximately 1.1 million expressed sequence tag (EST) reads. Contig assembly resulted in ca. 28,000 contigs representing 82% of the total reads with an average contig length of 834 base pairs (bp) and mean number of 67 reads/contig. Putative *Arabidopsis* homologs could be assigned for 85.6% of the contigs with greater than 10 ESTs/contig; another 4% to 5% had homologs in other species. Approximately 7% of the contigs did not have homologs, including many highly expressed genes (>100 ESTs/contig), suggesting genes possibly unique to cucumber or cucurbits. For contigs with *Arabidopsis* homologs, the overall distribution of putative gene function resembled the *Arabidopsis* genome. However, at individual time points there was differential representation of the most highly expressed functional groups. Gene expression levels were compared to the base timepoint of 0 dpp to identify changes unique to the different timepoints. The 4 dpp timepoint showed high expression of cell division and protein synthesis associated genes including cyclins, histones, and ribosome-related genes, all of which decreased at later time points. The 8 dpp timepoint showed high level expression of many growth related transcripts such as aquaporins, phloem associated proteins, and cell structure related genes. The 12 and 16 dpp fruit showed elevated expression of many abiotic and biotic stress related genes. Principle component analysis showed that the timepoints fell into three groups based on patterns of

gene expression, 0 and 4 dpp; 8 dpp; and 12 and 16 dpp. These groupings also reflect the different stages of growth: cell division, exponential expansion, and post-expansion, respectively.

3:15–3:35 pm

### Application of High Throughput Sequencing in Map-based Cloning of an Eastern Filbert Blight Resistance Gene in Hazelnut

Vidyasagar Sathuvalli\*

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Shawn Mehlenbacher

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Eastern filbert blight (EFB), caused by the pyrenomycete *Anisogramma anomala* (Peck) E. Müller, is a devastating disease of European hazelnut (*Corylus avellana* L.) in the Pacific Northwest where it is a serious threat to the industry's existence. A dominant allele at a single locus from the obsolete pollinizer 'Gasaway' confers complete resistance, for which several linked random amplified polymorphic DNA (RAPD) markers have been identified. Seedlings in a mapping population were scored for RAPD markers UBC152<sub>800</sub> and UBC268<sub>580</sub>, which flank the resistance locus, and recombinants used for fine-mapping. Our map-based cloning efforts use a BAC library for 'Jefferson', which is heterozygous for resistance from 'Gasaway'. Amplification with primers designed from RAPD marker and BAC end sequences identified 56 BACs in the EFB resistance region which were then sequenced using an Illumina IIG genome analyzer. Multiplexing with barcoded adapters reduced the cost, and paired-end reads facilitated de novo sequence assembly. With the help of high-information content fingerprinting (HICF), the BACs were aligned and a 275 kb contig was constructed. New primers designed from BAC sequences were used to amplify DNA of the resistant parent, susceptible parent and 'Jefferson'. The resulting PCR products were sequenced and compared, and single-nucleotide polymorphisms (SNPs) were identified. Sequence differences were used to assign the 'Jefferson' contigs to the resistant or susceptible parent. High-resolution melting (HRM) analysis and newly-developed SNP markers are being used for fine-mapping of the region.

3:35–3:55 pm

### SNP Mining in Blueberry Using Illumina GAI Sequencing

Nahla Bassil\*

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Todd Mockler

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Lisa J. Rowland

USDA ARS, Beltsville, MD; jeannine.rowland@ars.usda.gov

Genomic tools in blueberry are scarce despite the increased demand for and consumption of these fruits. The overall aim of a recently funded Specialty Crop Research Initiative project, “Generating Genomic Tools for Blueberry Improvement,” is to develop genomic tools for molecular breeding in blueberry. Specific objectives include the development of molecular markers for use in genetic diversity studies and construction of genetic linkage maps in diploid and tetraploid blueberries. Single nucleotide polymorphism (SNP) markers are the most prevalent genetic markers and well-adapted to high throughput variant detection. The advent of next-generation sequencing has dramatically increased the speed while decreasing the cost of DNA sequencing, thus enabling efficient variant discovery in plants with modest genomic resources. The Illumina Genome Analyzer II was used to identify SNPs in four diploid and five tetraploid blueberry lines that included parents of the mapping populations. We generated ~20 Gbp (~33x coverage of the haploid genome) of genomic DNA sequence data from four diploid and five tetraploid blueberry lines. These data were co-assembled into a draft reference genome assembly and the input reads were aligned to this reference to identify putative SNP markers. We plan to use these markers to identify quantitative trait loci associated with cold hardiness, chilling requirement, and fruit quality traits in highbush blueberry (*Vaccinium corymbosum*).

3:55–4:15 pm

### Quantitative Differential Gene Expression with NGS to Uncover Regulators of Short-day Induced Growth Cessation in Peach

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Measuring differential gene expression in non-model species requires methodologies that do not depend on extensive *a priori* knowledge of the genome or transcriptome. Subtractive methods and custom arrays have been valuable tools for gene differential expression and gene discovery in non-model crops, nonetheless these methods can be time-consuming and insensitive and the genomic tools they generate are only informative for the individual experiment. Next generation sequencing (NGS) offers many improvements for global expression profiling and discovery of differentially expressed genes in non-model species. Rapid advances in NGS technology (reduced cost and dramatically increased read numbers), now allow for direct sequencing and efficient global quantitative expression profiling with a depth that permits detection of relatively rare transcripts. Direct sequencing and transcript count data can be compared not just between samples from one experiment, but also among samples from different experiments. Extracting transcript counts from NGS data sets does require some *a priori* knowledge of the transcriptome, an investment in bioinformatic infrastructure/support and the adoption of statistical models appropriate for evaluating expression changes between large data sets. We recently performed a NGS differential gene expression experiment using the peach *evergrowing* mutant (which does not cease terminal growth under short days) and a sibling wild-type genotype. Terminal regions of wild-type and *evergrowing* peach were sampled at 0, 1, and 2 weeks following the transition to short days. During this time, elongation growth of the wild-type was reduced and the mutant was unaffected. Pooled RNA samples from each genotype and time combination (six total) were extracted, quality checked and quantified. Each sample was spiked with mRNA standards to assess the effect of transcript length and concentration on sequence recovery. Samples were submitted to the ISU DNA Facility for cDNA library synthesis and 75 cycle sequencing by Illumina™ GAII technology. Here we present our suggestions for using NGS for differential gene expression experiments gained from our experiences in peach. We will also compare the differential gene discovery success to our previous experience with the subtractive suppressive hybridization in a similar experiment.

4:15–4:45 pm

### Next-Gen Sequencing of the Sweet Orange Genome: Challenges and Outcomes

Fred Gmitter\*

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The International Citrus Genome Consortium (ICGC) has organized a collaborative effort, currently underway, to sequence the genome of a haploid line derived from ‘Clementine’ mandarin, using primarily Sanger technology. In parallel to and as an additional contribution to the ICGC efforts, the genome of hetero-

zygous sweet orange ( $2n=2x=18$ ; ~380Mb), the most economically important citrus cultivar group represented by the 'Ridge Pineapple' genome, is being sequenced jointly by Roche/454 and the University of Florida-ICBR Genome Sequencing Center using 454 technology. Currently, a combination of whole genome shotgun sequencing (WGS) and paired end sequencing of several large insert libraries using FLX and Titanium platforms, has produced nearly 30X sequence coverage; another 1.2X WGS Sanger coverage produced from 'Ridge Pineapple' previously by USDOE-Joint Genome Institute was also included in the cumulative reads. Several rounds of assembly followed using the Newbler assembly platform, finally resulting in an assembly that is amenable to gene modeling and prediction, to be followed by annotation. The current status of the project in July 2010, including progress in assembly, gene prediction and annotation, will be presented. Additionally, the underlying motivation for the Florida citrus industry's decision to partially support both of these genome sequencing projects will be discussed, as that will highlight the first priority applications of the information to benefit citrus growers in their battle against serious diseases which threaten their continued existence.

4:45–5:15 pm

**Next-Generation Sequencing of the Tomato Transcriptome: A Resource for SNP Discovery, High Throughput Genotyping, and Translational Research**

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Bioinformatic and computational comparison of sequences within and across species has empowered basic and applied research. The identification of Conserved Ortholog Set (COS) genes, the ability to predict intron sequences based on reference genomes, and databases organized around metabolic pathways have further facilitated comparative analysis. Next generation sequencing is now providing much more extensive sequence data and genomic resources that extend horizontally to encompass variation within and between species. To assess the genetic diversity within tomato germplasm, we constructed normalized cDNA libraries from six inbred tomato varieties using root, leaf, flowers, fruit and callus tissue. Using Illumina GAI "next generation" sequencing technology, we generated >2.5 Gb of total sequence for each tomato cultivar, respectively. The 60 bp reads, single and paired end, were assembled using Velvet to generate 32.5 Mb of transcriptome sequence from tomato. These new sequences give us tools for further analysis of the Solanaceae genome landscape, including identification of gene duplications between species, a compendium of tomato Single Nucleotide Polymorphisms (SNPs), a description of haplotype blocks across domesticated lineages, and the proportion of the genome under purifying/diversifying selection. These data provide resources to facilitate applied objectives while also providing a description of the effect of human selection on genomes of horticultural crops.

5:15–5:45 pm

**From Sequence to Genomics Assisted Breeding—the Role of Bioinformatics**

Doreen Main\*

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Bioinformatics is the application of information technology to the processing, analysis, storage, visualization and dissemination of DNA data. For large scale data generated by next generation sequencing bioinformatics is integral to its utility. Processing and analysis algorithms are used to identify high quality sequences, assemble them into longer EST or genome contigs, identify SNPs and other polymorphisms, map them to genomes, and do comparative analysis. Access to centralized databases with online tools enables basic, translational and applied researchers to submit, search and analyze integrated genomic, genetic and breeding information.

Tuesday, August 3, 2010

Desert Salon 4-6

## Local, National, and Global: The Impacts of Local Foods?

8:00 am–12:00 pm

Sponsor: Local Food Systems Working Group

Moderator: Curt Rom, Professor

University of Arkansas, Fayetteville, AR; crom@uark.edu

The objectives of this colloquium are: 1. To describe local food systems and programs being used to promote local foods. 2. To discuss the impacts local food production can have in local and rural economies and the value of local foods, both financially and socially, to people and communities 3. To discuss the sustainability of local foods and address issues of economic, environmental and social impacts of local foods. 4. To identify knowledge gaps and key questions related to local foods to be studied and resolved 5. To stimulate discussion that leads to action by ASHS members in the area of local/regional food production, marketing, and assessments.

Local foods have been increasing in interest both among consumers and among retail marketing organizations. The importance of local foods to local economies and consumers has been topics of popular press and media. However, the vast majority of the food supply in the U.S. comes from industrial production centers. The development of local/regional food production is an opportunity as well as a challenge for small and medium scale specialty crop producers and is a chance to expand the agricultural production and consumption of specialty crops. In order for ASHS members to be able to address the challenges and opportunities through research, education, and outreach, members must be informed of the advantages and disadvantages of local foods.

8:00–8:10 am

### Local, National, Global: Introduction to Local Food Systems Colloquium

Curt R. Rom\*

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In the 20<sup>th</sup> century, food production in the U.S. migrated away from farms surrounding communities supporting a local food system to industrial production centers often distant from consumers. The efficiencies of both scale and environmental conditions in the production centers provided inexpensive food year-around to American consumers. The food, however, had to travel significant distances from the farm field to the consumer table with a significant supply chain to support the storage, transport, and sale of the mass-produced food products. With recent concerns about food miles, rising costs of petroleum-based fuels used in transport, consumer environmental and health concerns and perceptions, increasing interest in product quality and freshness, as well as interest in local economies, there has been increased consumer interest in more locally or regionally produced foods.

This interest has stimulated a significant number of farmers' markets as well as programs by retail food chains acquiring, marketing and selling local foods. With the increased interest in locally produced foods come both opportunities as well as challenges including availability of farms, farmers and products, appropriate scale-neutral or small scale technologies needed for locally produced foods, new supply chain systems to handle multiple small and medium scale producers, etc. Further, questions of sustainability of food production in smaller scale and non-optimum environments become apparent. With the perceived increased interest and need for more local foods there is a need to have programs to initiate and sustain the food production system. This colloquium is developed to explore issues of local food systems addressing the opportunities and challenges so that appropriate science may be initiated, technologies developed and educational and outreach programs developed and implemented to support local food systems.

8:10–8:50 am

### Government Support for Development of Local Foods: Programs and Policies

Ann Wright\*

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8:50–9:30 am

### First Principles: Envisioning the Place of Local and Regional Foods in the U.S. Food System through the Lenses of Health and Sustainability

Christian Peters\*

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In recent years, public interest in food and agriculture has grown in tandem with fascination about locally produced foods. Willingness to promote local and regional food production can now be found in the U.S. Department of Agriculture, suggesting that the movement has entered the mainstream. Given the degree of public excitement and potential public investment, it is time to ask where local and regional foods fit within the predominantly national, and increasingly international, U.S. food system. This talk will address this question in two parts. Part one will examine the capacity of local and regional agricultural resources to meet food demands. Using research on the land requirements of the human diet and potential local foodsheds of New York State as a foundation, the capacity for producing food locally and regionally will be placed in the context of total national food needs. The available evidence provides a compelling argument that although not all food can be local, substantial capacity to produce food does exist close to most urban centers in the United States. How much of this local capacity should be directed at meeting local needs remains an open question. There is no single vision for the proper place of local and regional food within the American food system. Thus, part two of the talk will make the

case that the role of local and regional food should be shaped by the larger goals of health and sustainability. Humanity faces the challenge of continuing to feed a growing world population while also providing more balanced diets, adapting to climate change, mitigating greenhouse gas emissions, protecting environmental quality, reducing dependence on non-renewable resources, and supporting rural communities. Meeting this challenge will be a daunting task, and success is not guaranteed. Therefore, the roles of all food systems (local, regional, national, and international) should be evaluated based on their potential to address these problems.

9:30–10:10 am

### **The Disappearance of the Middle Size Farm: Models to Respond to Growing Markets for High Quality, Differentiated Food Products**

Steve Stevenson\*

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Very small and very large farms and ranches have increased in numbers, farms-of-the-middle have been “disappearing”. Caught in the middle as the American food system divides into global marketing of agricultural commodities, on the one side, and direct marketing of food to local consumers, on the other, many traditional family farms across the country are increasingly at risk. Mid-sized “farming occupation” farms have been challenged as they are often too small individually to compete successfully in international agricultural commodity markets and not positioned well to directly market food to local consumers. A significant part of the peril is the result of increasing concentration in the processing and retail sectors of the system which creates power imbalances in market relationships. Such imbalances enable strategic behavior in traditional agrifood supply chains that often seriously disadvantage the least powerful participants, notably farmers and other food enterprises in the middle like regionally-based food processors, distributors, and retailers. Restoring balance to these agrifood economic relationships will require changes in both private sector business models and public policy. Shifts are occurring in the food system and in the larger social economy that can provide significant opportunities to develop farming and food systems in which a re-formed agriculture-of-the-middle can prosper. Following Europe’s lead and emphasizing issues of social justice and environmental responsibility, a growing “fair trade” movement has developed in the U.S. Progressive leaders in some sizeable food corporations are recognizing the confluence of their interests with the maintenance and regeneration of an agriculture-of-the-middle. Farms-of-the-middle have both the capacity and the flexibility to partner with each other and with other supply chain parties to respond to these expanding markets for significant volumes of high-quality, differentiated food products.

10:10–10:50 am

### **Agile Agriculture—Connecting Small Farms with Large Markets and Providing Benefits for Agricultural Producers, Food Distributors and Retailers, and Consumers**

Mike Faupel\*

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The goal of Agile Agriculture is to facilitate the availability of a safe, consistent and reliable supply of relevant products for purchase in the marketplace by large-scale buyers. Unmet market demand for locally produced agricultural products has created opportunities for small/mid scale producers to choose marketing strategies that best fit their individual operations; strategies range from direct marketing (i.e., farmers’ markets and CSAs), specialty wholesale and can also include large scale wholesale under some conditions. The University of Arkansas Applied Sustainability Center has taken several approaches to facilitate entry of small/mid scale producers into large markets with the foundations of promoting sustainable agricultural production systems, ensuring profitability to producers and distributors, providing social benefits of local food systems and delivering healthy products to consumers. Potential benefits to producers of this type of market opportunity include increased profitability when certain requirements are met, and allowance of focus on operational efficiencies. Benefits to food distributors and retailers can include meeting consumer desires for local and regional products, reducing transportation costs and greenhouse gas emissions, providing fresher products to consumers and reducing food waste, and development of business opportunities due to robust local economies. Consumers can also benefit from these type of systems, as confidence is increased by forming connections with agricultural supply chains, local economies are enhanced and availability of fresh, healthy affordable products is increased.

10:50–11:30 am

### **Developing and Promoting Sustainable, Local Food Initiatives**

Nancy G. Creamer\*

North Carolina State University, Raleigh, NC; nancy\_creamer@ncsu.edu

The Center for Environmental Farming Systems develops and promotes food and farming systems that protect the environment, strengthen local communities, and provide economic opportunities in North Carolina and beyond. Established as a partnership between NCSU, NC A&T State University, and the NC Department of Agriculture and Consumer Services, CEFS was envisioned by and continues to work with state and federal agencies, and non-governmental organizations, farmers, and

citizens on sustainable food systems initiatives. A shift towards a local and sustainable food economy has benefits, including economic development, farming and food job creation, open space preservation, decreased use of fossil fuel, increased consumer access to fresh foods, and improved food security. Last year, North Carolinians spent >\$35 billion on food. If all NC residents spent 10 %of their food budgets on local foods (\$1.05 per day), \$3.48 billion dollars would be generated for the state's economy annually. Increasing the consumption of fresh, healthy foods can address both disease incidence and health care expenditures, particularly in underserved communities where fresh food is often least accessible. CEFS launched a Farm to Fork initiative to build NC's local food economy. More than 1,000 citizens participated, including those working in agriculture, fisheries, community organizing, education, faith, finance, nutrition, philanthropy, planning, public health and policy, small business, government, and outreach. The Farm-to-Fork process involved an advisory team, six regional meetings, eleven working-issue teams (WITs), and a statewide summit. Working issue teams were developed around 11 areas: Formalizing the Initiative, Farm-to-School, Institutional and Retail Markets, Public Health and Food Access Disparities, Direct Markets,

New and Transitioning Farmer Support, Community Gardens, Land Use and Local Government Initiatives, Youth and Social Networking, Consumer Outreach and Marketing, Processing and other Food Systems Infrastructure. Successes include a comprehensive, action-oriented statewide guide: *From Farm to Fork: A Guide to Building North Carolina's Sustainable Local Food Economy*; a listserv with 1000 subscribers & participants; a directory of food system activities ([www.ncfoodnet.com](http://www.ncfoodnet.com)); a commitment from NC Cooperative Extension to designate a local food coordinator in every county in the state; legislation establishing a North Carolina Sustainable Local Food Advisory Council (and a youth statewide council is under development); a networking meeting for funders to encourage collaboration around this initiative; and resources to support a 10% Eat Local Campaign, with the largest food service company in the world to participate with all of its NC venues. Lessons learned plus other innovative programs will be reported.

11:30–12:00 pm

**Panel Discussion**

Wednesday, August 4, 2010

Desert Salon 7

## Water Management and Plant Performance in a Changing Climate

8:00 am–12:00 pm

Sponsor: Water Utilization and Management (WUM) working group

Moderator: Gladis Zinati  
Rutgers University, New Brunswick, NJ; zinati@aesop.rutgers.edu

**Objective:** 1.To illustrate the importance of responses of horticultural crops to changes in climate, 2.To discuss the impact of water deficit and carbon dioxide on crop performance 3.To describe irrigation scheduling strategies and use of sensors to optimize water use and crop growth for a variety of horticultural crops in a changing climate.

Throughout history, leading agricultural enterprises have dealt with changes in climate through changes in management decisions. Crop responses in a changing climate reflect the interplay factors among rising temperatures, changing water resources, and elevating carbon dioxide concentrations. The colloquium will examine: 1) key issues on adaptations of plants to water limited conditions and the profound changes in physiological processes and crop performance due to climate change, and 2) water management approaches and irrigation scheduling to optimize horticultural plant performance under water deficit. Discussions on how to adapt farming to climate change could be learning lessons to how to make agriculture contribute to climate change mitigation. In this colloquium water availability for horticultural crops in a changing climate will be presented by the keynote speaker Mike O'Neill, National Program Leader for Water Resources. Implications of elevated atmospheric carbon dioxide on plant performance and water use efficiency will be discussed by Stephen Prior. Insights on physiological and morphological interactions that modulate water exchange among plant parts will be provided by Bill Bauerle. Responses of tropical trees to climate uncertainty in South East Asia will be summarized by Roger Kjølgren. Drought-resistant mechanisms of turfgrass as affected by availability of water and climate change will be elaborated by Richard White. The use of plant-based approaches to deficit irrigation in fruit trees and vines will be discussed by Ken Shackel. Automation of irrigation

scheduling using soil water tension will be demonstrated by Clinton Shock. Discussion of those timely topics will help to clarify our current understanding of climate change and water relations and identify future research needs.

8:00–8:05 am

### Welcome and Introduction

Gladis Zinati\*  
Rutgers University, New Brunswick, NJ; zinati@aesop.rutgers.edu

8:05–8:40 am

### Water Availability for Agriculture: Meeting the Challenge in a Changing Climate

Mike O'Neill\*  
National Institute of Food and Agriculture, Washington, DC; moneill@nifa.usda.gov

Agriculture—in its broadest form—is the greatest consumptive user of water resources in the United States and around the world. Over the next two decades, perhaps the greatest challenge facing agricultural producers will be adapting water management to an increasingly variable climate. Adaptation will be extremely difficult, in part, because other demands for water, e.g., energy, domestic, industrial, municipal—will continue to increase during this time. Despite considerable improvements in irrigation technology, product development, and other water saving approaches, agricultural producers will be expected to reduce water consumption and improve or protect water quality of water discharged from agricultural operations. In 2004, the National Institute of Food and Agriculture embarked on an effort to address Agricultural Water Security—ensuring sufficient water of the appropriate quality at the needed time to meet demands for food, fiber, and other agricultural goods and services. This effort has identified six broad areas where agricultural research, education, and extension can impact water management to achieve agricultural water security. The six areas are: Biotechnology, Water Reuse, General Conservation, Irrigation Efficiency, Water Markets and Trading, and Drought Preparedness. We present an overview of the six areas and specific opportunities for agriculture—and specifically horticultural and specialty crop producers—to adapt to climate change through improved water management.

8:40–9:05 am

### **Implications of Elevated Atmospheric CO<sub>2</sub> on Plant Growth and Water Relations**

Stephen Prior\*

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Empirical records provide incontestable evidence for the global rise in CO<sub>2</sub> concentration in the earth's atmosphere. Plant growth can be stimulated by elevation of CO<sub>2</sub>; photosynthesis increases and economic yield is often enhanced. The application of more CO<sub>2</sub> can result in less water use. Competition between crops and weeds could be altered. Increases in root biomass could also influence soil carbon storage and trace gas emissions. Having looked at the available data base, we will offer a series of priority targets for future research.

9:05–9:30 am

### **Predicting Transpiration Response to Climate Change: Insights on Physiological and Morphological Interactions That Modulate Water Exchange from Leaves to Canopies**

Bill Bauerle\*

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Leaves are key factors in the global water exchange cycle. For leaves, stomata is assumed to be the primary control of transpiration, however, when ascending beyond the single-leaf scale to that of the crown and canopy, the dominant transpiration control can become the thickness of the boundary layer—a consequence of environment and canopy structure interactions. Here we separate the morphological and physiological interactions and assess their contributions to transpiration along the leaf-to-atmosphere gas exchange continuum. Multi-scale analyses illustrate the quantitative importance of leaf-to-atmosphere microclimate interactions at interlocking scales of observation.

9:30–10:05 am

### **Rearranging the Puzzle Pieces: Tropical Tree Responses to Climate Uncertainty in Southeast Asia**

Roger Kjelgren\*

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Southeast Asia includes both the wet characterized by brief dry periods, and monsoonal tropics divided between distinct wet and dry seasons. Both an uncertain future and the reconstructed paleo climate point to likelihood of higher temperatures, more intra-monsoonal drought, and potentially complete monsoonal failure. Tree species in monsoonal climates typically have deeper rooting to avoid dry season drought as long as possible, but tend to be divided between evergreen species tolerating the 4–6 month drought, and drought deciduous of many flavors that vary in terms of timing and duration of defoliation. Drought deciduous species typically have much higher transpiration and photosynthetic rates than evergreen species that is approximately similar on a yearly basis. Downscaled IPCC air temperatures using the A4 scenario suggest that deciduous species will expand area at the expense of evergreen species, possibly due to greater capacity for transpirational cooling through more open stomata that would allow more yearly photosynthesis. Dry evergreen species are more likely to be subjected to higher vapor pressure deficits and more prolonged stomatal closure, suggesting they may be less adaptable to climate change.

10:05–10:35 am

### **Water Relations of Turfgrasses and Implications for Water Conservation as Climate Change**

Richard White\*

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Perennial grasses used for turf express a number of drought resistance mechanisms to maintain a favorable water balance. These mechanisms are important for drought survival and impact the amount of supplemental irrigation needed to sustain turfgrass vegetative cover in amenity landscapes. Yet, as climate change causes increased evaporative demand within some increasingly adverse environments, management systems that capitalize on physiological mechanisms of drought resistance will be required to ensure turfgrass survival and irrigation water conservation.

10:35–11:10 am

### **Plant-based Approaches to Deficit Irrigation in Trees and Vines**

Ken Shackel\*

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Field experiments have been performed on grapevine as well as a number of woody tree species (almond, prune, pear, cherry) to determine the relation of plant water potential to a number of indices of plant physiological activity (leaf conductance, vegetative growth and fruit growth and composition). Horticultural benefits of regulated deficit irrigation (RDI) have been documented in many crops (grapevine, almond, prune, cherries), but management of irrigation to achieve these benefits is difficult without a reliable plant-based measure of stress. Midday stem water potential (SWP) has proven to be a robust, reliable, and practical measure of stress, and closely related to physiological responses at the leaf and whole plant level (stomatal conductance, vegetative growth, and fruit growth and composition such as soluble solids and fruit color). Attempts are currently underway to estimate SWP from remotely and locally sensed parameters such as canopy temperature and canopy spectral characteristics.

11:10–11:40 am

### **Soil Water Tension, a Powerful Tool for Productivity and Stewardship**

Clinton C. Shock\*

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Feng-Xin Wang

China Agricultural University, Haidian, Beijing; fxinwang@yahoo.com.cn

A fundamental way to schedule irrigation is through the monitoring and management of soil water tension (SWT). Soil water tension is the force necessary for plant roots to extract water from the soil. With the invention of tensiometers, SWT measurements have been used to schedule irrigation. There are seven different types of field instruments used to measure SWT, either directly or indirectly. Automation of precision irrigation by SWT is a powerful tool to determine optimal irrigation criteria for plant performance. Specific SWT criteria for irrigation scheduling have been developed to optimize the production and quality of vegetable crops, field crops, trees, shrubs, nursery crops, and for the management of landscape plants. The known SWT criteria for irrigation scheduling will be reviewed. By utilizing the ideal SWT and adjusting irrigation duration and amount, it is possible to simultaneously achieve production and environmental stewardship goals.

11:40–11:50 am

### **Panel Discussion**

Gladis Zinati\*

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**Thursday, August 5, 2010**      **Desert Salon 4-6**  
**Improvement of Horticultural  
Crops for Abiotic Stress Tolerance**

Primary Sponsor: Vegetable Breeding (VGBR) Working Group

Co-Sponsor: Environmental Stress Physiology (STRS) Working Group

Moderator: Beiquan Mou

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**Objective:** 1) To discuss the need, significance, and benefit of improving fruits, vegetables, and ornamental crops to adapt to heat, cold, salt, drought, and other stresses associated with global warming and climate change. 2) To assess the current status and challenges of research in stress physiology, molecular biology, genomics, plant transformation, germplasm enhancement, and crop breeding for tolerance to abiotic stresses. 3) To identify opportunities, strategies, and priorities for future research and development in this important field.

Global warming and climate change have been widely accepted as facts. The changing environments pose serious challenges to global agriculture and place unprecedented pressures on the sustainability of horticulture industry. Adapting horticulture to future conditions is essential to meet the need of growing population and increasing demand for fruits, vegetables, and other horticultural products. Forecasts show that warming over the next several decades will take place irrespective of any action taken today. Therefore the development of horticultural crops that can cope with heat, cold, drought and other climate extremes brought by a warming planet may well be the single most important step we can take to adapt to the changes we face today and in the future. However breeding a new variety takes time, often about 10 years. Our ability to breed these new varieties is undermined by the rapid loss of the biological basis of horticulture—the genetic diversity of plants, which is in turn accelerated by climate changes. In addition, it is estimated that more than 20% of all cultivated lands around the world contain levels of salts high enough to cause stress on crop plants, a situation worsened by global warming. There is an urgent need to mitigate these abiotic stresses through improvement of horticultural crops. This enormous and difficult task requires tremendous efforts from multiple disciplines. Stress physiology research identifies mechanism of stress tolerance and provides approach, method, and traits for screening stress-resistant genotypes. Molecular biology and genomic studies lead to a better understanding of the structural organization and functional properties of genetic variation for stress-related traits, allow gene-based selection through identification of molecular markers and high-throughput genotyping techniques, and increase the genepool available including new sources of stress-tolerant traits or transgenes. Plant breeders translate these findings into stress-tolerant crop varieties by using all tools available that include germplasm screening,

marker-assisted selection, plant transformation, and conventional breeding methods. In this colloquium, leading scientists in this field will introduce the need, significance, and benefit of stress tolerance in fruits, vegetables, and ornamental crops; discuss the current status and challenges of research in stress physiology, molecular biology, genomics, plant transformation, germplasm enhancement, and crop breeding for resistance to abiotic stresses; and identify opportunities, strategies, and priorities for future progress in this important field. With its summer heat and dry weather, Palm Desert is the perfect place to discuss this topic.

8:00–8:35 am

**Adaptive Response of Plants to Freezing Stress:  
A Physiological Perspective**

Rajeev Arora\*

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Lisa J. Rowland

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Freezing is a major environmental stress during the annual cycle of temperate zone perennials. Freeze injury can occur due to mid-winter temperatures that are colder than the tolerance threshold of a tissue/plant or due to untimely freezing temperatures before cold acclimation (development of freezing tolerance) in the fall or after deacclimation (loss of acquired freezing tolerance) in the spring. Therefore, the timing and extent of seasonal cold acclimation and deacclimation are of critical importance for winter survival, particularly in view of the climate change, i.e. unpredictable extreme weather occurrences. For example, plants may acclimate less completely to cold if exposed to milder autumn climate, and thus may be damaged by even mild sudden frosts. Alternatively, they may deacclimate prematurely due to unseasonable, midwinter warm spells and be damaged by the cold that follows. Efficient cold acclimation ability, high deacclimation resistance, and efficient reacclimation capacity are, therefore, important components of the winter survival in overwintering perennials. Understanding the fundamental mechanisms of cold acclimation is of key importance in efforts to develop cold-hardy plants. Spatial redistribution of cellular water during a natural freeze–thaw episode imposes numerous physical and biochemical stresses at the cellular level. Cold acclimation is, therefore, a complex quantitative trait involving a sizable suite of genes and the product of integrated processes that coordinate the induction of freezing tolerance. Transcriptional studies, in combination with mutational and transgenic plant analyses, have revealed a complex transcriptional network operating during cold stress. Some of these gene products likely function in stress tolerance directly (dehydrins, aquaporins, enzymes for fatty acid biosynthesis, osmolytes, etc.), while others are involved in signal transduction and the regulation of gene expression (transcription factors, protein kinases, phosphatases, etc.). Also, depending upon how plants are cold-acclimated by

the experimenters, some of these genes might, conceivably, be associated with cold shock and not true acclimation. For example, unrealistic artificial acclimation regimes, such as a sudden exposure to cold in growth chambers, can result in “shock” rather than gradual “acclimation.” Current status of cold acclimation research will be discussed in light of results obtained by various research groups including our own recent work with *Rhododendron* and *Vaccinium*.

8:35–9:10 am

### **Characterizing Water Use Efficiency (WUE) and Water Deficit Responses in Apple (*Malus ×domestica* and *Malus sieversii*)**

Carole Bassett\*

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Reduced availability of water for agricultural use has been forecast for much of the planet, due in part to global warming which has contributed to numerous cycles of drought worldwide and due in part to greater urban demand for water in large metropolitan areas. Strategic improvement of water use efficiency (WUE) and drought tolerance in perennial crops, like fruit trees, could reduce water use without compromising yield or quality. We studied water use in apple trees using ‘Royal Gala,’ a relatively water use efficient cultivar, as a standard. To examine whether or not genes useful for improving WUE are represented in a wild relative genetically related to *M. ×domestica*, we surveyed *Malus sieversii* for traits associated with WUE and drought tolerance utilizing material collected from xeric sites in Kazakhstan. One such collection has been maintained at Geneva, NY, and surveyed for various phenotypes, as well as simple sequence repeats (SSRs). These data suggest that most of the diversity in this population is contained within a subpopulation of 34 individuals. Our results indicate considerable diversity in this group with respect to WUE and transpiration, while other traits, such as leaf number and size, as well as stomatal size and density show little or no differences. These results imply that genetic diversity has resulted in changes in the biochemistry, uptake and/or transport of water, carbon or oxygen that have allowed these trees to survive in water-limited environments.

9:10–9:45 am

### **Options for Developing Salt Tolerant Crops**

Wayne Loescher\*

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Soil salinization is a major factor limiting agricultural productivity, reducing crop yields on 25% to 30% of irrigated land in the U.S. and about 40% of irrigated land worldwide. An inevitable consequence of irrigation, salinity is consequently a problem in containerized and controlled environment production and management. It is often a problem on marginal lands worldwide, particularly in arid regions where salinization is essentially irreversible because fresh water for leaching is not available. However, many plants are salt tolerant. Some partition or accumulate potentially toxic levels of salt to older tissues that are shed, some have active exclusion structures, e.g., salt glands, and some at the cellular level specifically exclude salts from the cytosol. Although salt tolerance is seen as a complex trait and breeding improvement has been slow, recent experiments suggest potential for creating new salt tolerant crops. These involve various transgenes that utilize transport mechanisms that sequester salt in the vacuole or exclude it from the cytosol in the apoplast, or alternatively use osmoprotectants, e.g., proline, ectoine, betaines, polyols, and trehalose, that nullify toxic effects of salts, by raising osmotic pressure in the cytoplasm, by stabilizing proteins and membranes when salt levels or temperatures are unfavorable, or by effects on stress related biosynthetic and signaling pathways. There are also regulatory genes involved in cold and drought tolerance that may play a role. There are now a number of first generation single gene examples of these, but they are not always without problems. Salt Overly-Sensitive 1 (SOS1) encodes a plasma membrane Na<sup>+</sup>/H<sup>+</sup> antiporter from *Arabidopsis* that is a salt excluder. Similarly, an *Arabidopsis* AtNHX1 antiporter on the tonoplast sequesters salt in the vacuole. Both of these require proton motive forces generated by membrane located ATPases or pyrophosphatases, and both can result in substantial salt tolerance in transgenic plants. Alternatively, a C-repeat binding factor/drought responsive element binding factor (*CBF3/DREB1a*) encodes a transcription factor for abiotic stress gene regulation, and while this has some positive effects on salt and drought tolerance there can be negative effects on growth. Several transgenes result in accumulation of osmoprotectants. One is the mannose-6-phosphate reductase gene (*M6PR*) that codes for an enzyme resulting in mannitol biosynthesis, and plants transgenic for M6PR that ordinarily lack mannitol become substantially salt tolerant. However, not all osmoprotectant transgenes result in equivalent levels of protection, and some have been deleterious. We will review these and other options and compare their potential.

9:45–10:20 am

### **Abiotic Stress Gene Families in the Diploid Strawberry, *Fragaria Vesca***

Janet Slovin\*

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Pablo Rabinowicz

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Strawberry is an herbaceous perennial member of the Rosaceae family, which includes several important fruit crops as well as ornamentals. The commercial dessert strawberry, *Fragaria xananassa*, is octoploid and not readily amenable to genetic and genomic research. Genetic and genomic resources are rapidly being developed for the diploid woodland strawberry, *F. vesca*, so that it can be used as a model system for *Fragaria*, as well as for other members of the Rosaceae family that are more difficult to transform or work with in the laboratory. One of these resources is a set of about 42,000 ESTs generated from five separate cDNA libraries representing transcripts from water, temperature and osmotically stressed seedlings and plants. These ESTs were assembled into 11,836 contigs and singletons, and these sequences were annotated using gene ontology (GO) terms. Over 1200 sequences with no match to available Rosaceae ESTs were found, including 6 that were assigned the “response to stress” GO category. The largest number of different transcripts was found in response to cold treatment, while the highest numbers of ESTs for a specific sequence were found with high temperature or with high temperature in combination with osmotic stress. Temperature stress resulted in the highest number of sequences in the “response to stress” GO category. cDNA libraries were not normalized or subtracted in order to retain members of known stress gene families. As expected, among the twenty most abundant sequences found in the EST set are seventeen that encode well-known stress response proteins, including metallothioneins, a dehydrin, a secretory peroxidase, and low molecular weight heat shock proteins (LMW HSP), all of which are found to belong to small gene families. Several stress gene families, LMW HSP, HSP70, dehydrin, and others were found and analyzed for homology to sequences from Arabidopsis. The abundance of specific family members in each stress library was used as an indication of expression of the corresponding gene. Predicted stress expression patterns in different plant tissues are being confirmed by RTPCR, with an emphasis on expression in reproductive organs in response to abiotic stresses.

10:20–10:55 am

### **Improvement of Horticultural Crops for Semi-arid and Arid Lands**

Dennis T. Ray\*

University of Arizona, Tucson, AZ; dtray@email.arizona.edu

Large areas of North America, as well as worldwide, are semi-arid and/or arid environments with abiotic stresses, such as

temperature and water supply, limiting agricultural production. Improved germplasm with increased tolerance to drought and heat can help support farming/horticultural sustainability of these areas, as well as the development of new crops to replace traditional agricultural production.

10:55–11:30 am

### **Breeding Vegetables Adapted to High Temperatures: A Case Study with Broccoli**

Mark Farnham\*

USDA ARS, Charleston, SC; mark.farnham@ars.usda.gov

Broccoli (*Brassica oleracea* L. Italica Group) has emerged in the last few decades as one of the most economically important vegetables grown in the United States. Evidence indicates that head development of most broccoli varieties is arrested by temperatures exceeding 30 °C, temperatures that are nearly optimal for vegetative growth. This general observation tends to limit U.S. broccoli production to climates lacking high temperature fluctuations with the vast majority of the crop produced in California. However, increasing interest in growing broccoli in eastern environments has stimulated efforts to produce broccoli under conditions that are hotter and less optimal for quality head production. For about 15 years the USDA-ARS broccoli breeding and genetics project at the U.S. Vegetable Laboratory (USVL) in Charleston, SC has conducted a breeding program to select broccoli adapted to relatively high temperatures of the southeastern U.S. The program was initiated in the early 1990s using a few commercial hybrids and other noncommercial broccolis obtained from other sources. All breeding and selection trials have been conducted from May through August in Charleston with head production occurring when temperatures typically exceed 30 °C during daytime hours and remain high during the night. The program has employed a conventional pedigree breeding approach in which different inbreds are crossed to one another to form hybrids that are subsequently selfed to create segregating populations. Through several rounds of selection and recombination, lines increasingly adapted to summer conditions of the Southeast have been identified. The resulting broccoli lines perform very similar regardless of the temperature conditions they are grown in, making them different than most broccoli bred for adaptation to western environments. The USVL broccoli might be appropriately described as “heat resistant” or “heat insensitive.” Future improvement of broccoli for high temperature adaptation must recognize the role that vernalization plays in broccoli, the likelihood that hybrid vigor will be important at high temperatures, and that the trait must be considered complex. Current efforts are underway to determine heritability of adaptation to the high temperature selection environment and to identify important genetic factors that condition the trait.

**Monday, August 2, 2010**                      **Room: Springs A&B**

**Workshop 1:**

**ASHS Primer**

Sponsor: Collegiate Activities Committee (CAC)

Coordinator: Tracy A.O. Dougher, [tracyaod@montana.edu](mailto:tracyaod@montana.edu)

**Objective:** To provide students attending the ASHS Conference with basic information on what opportunities are available and how they can reap the most benefits from attending the ASHS conference.

Attending an ASHS professional conference as an undergraduate student or graduate student for the first time can be an overwhelming experience. To help sort out the mystery of where to go, what to do, how to find where the talks are, what can I attend or even what is ASHS, this workshop is designed to provide basic information on what opportunities are available to students attending a national conference. This workshop will answer student questions about the conference and help guide students to gain the most from their conference experience.

**Monday, August 2, 2010**

**Springs H & I**

**Workshop 2:**

**Beyond the Elements: Alternative Amendments and Their Impact on Plant Health, Growth, and Productivity**

Sponsor: Organic Horticulture (ORGH) Working Group

Coordinator: Danielle D. Treadwell, [ddtreadw@ufl.edu](mailto:ddtreadw@ufl.edu)

**Objective:** This workshop will review the scientific basis for alternative amendments including teas, humates, and microbial products in organic farming systems. Our working group desires to summarize advances in knowledge on the predominant mechanisms and modes of action of alternative amendments, review the role of cultural practices on amendment efficacy, and discuss their application in farming systems.

Organic and conventional farmers are increasingly utilizing a diversity of alternative amendments to improve plant health, growth and productivity. Amendments are used to reduce the incidence of soilborne disease, improve the efficiency of nutrient cycling, and boost the plant's natural defense system. The implementation of the National Organic Program's Final Rule in 2002, the phase-out of methyl bromide, and a desire to reduce input costs are factors associated with the dramatic increase in the number of commercially-available alternative amendments. Typically these products can be grouped into four categories based on their function and/or activity area: 1) those that induce systemic acquired resistance in the plant; 2) those that act upon soilborne pests or, 3) on pests that reside on

plant surfaces; and 4) those that enhance the plant's growth and development. Unfortunately, it is often difficult to separate the "snake oils" from the products that do, in fact, provide benefits as described. Many farmers state positive results following the addition of compost and vermicomposts teas, microbial products, biopesticides and humates that are made on-farm or purchased from area suppliers. However, ingredients, processing, shipping, handling, and application strategies are variables that may affect the efficacy of alternative amendments. Additionally, ecological and biological conditions vary among sites, so results are not always consistent. Scientific knowledge of the function and efficacy as well as cultural practices of these amendments is needed to facilitate development of sustainable, biologically-based farming systems. The Organic Horticulture Working Group will host a panel discussion on the scientific basis of alternative amendments in cropping systems. Panelists will present and discuss topics including the modes of action of alternative amendments, roles of specific compounds and organisms, and effects of cultural practices on amendment efficacy. Panelists will present information based on their own research and experience. The discussions will be focused on research methods to evaluate the efficacy of products that provide multiple ecosystem services, the role of state and federal laws and regulations on product use, and areas in need of additional research. Audience participation is encouraged.

**Monday, August 2, 2010**

**Desert Salon 1-3**

**Workshop 3:**

**Sustainability and Production in California: A Grower's Forum**

Sponsor: Floriculture (FLOR) Working Group

Coordinator: Kimberly K. Moore, [klock@ufl.edu](mailto:klock@ufl.edu)

**Objective:** The objective of this workshop is to invite California growers to participate in a panel discussion. A series of prepared questions will be given to the growers prior to the workshop, such as how do you define and measure sustainability? What regulatory constraints are you facing? What challenges are you facing with regards to water and nutrient management? What types of research do you think would be most beneficial to your business? What are the biggest issues that you face? Do you have comments on what universities should or should not be teaching the students you hire? There also will be an open question and answer session between the audience and the grower panel.

Growers in California have been invited to participate in a discussion forum about sustainability and production issues. The workshop will begin with a short introduction of each grower on the panel followed by an open discussion. The growers have been asked to think about the following issues: how do they define sustainability and how do they measure it, what regulatory constraints are they facing with regards to water and other issues, what challenges are they facing with regards to water and nutrient management, what changes have they made in their

production system to protect and conserve water, what types of research do they think would be most beneficial for their business, what are the biggest challenges they face, do they have any comments on what university faculty should or should not be teaching the graduates that they hire? We hope that this will be an open discussion with additional questions from the audience.

**Monday, August 2, 2010**

**Springs D & E**

**Workshop 4:**

## **Increasing Effectiveness of Master Gardeners: Techniques That Work**

Sponsor: Consumer Horticulture and Master Gardener (CHMG) Working Group

Coordinator: Lelia Scott Kelly, leliak@ext.msstate.edu

**Objective:** Provide a forum for sharing the most successful techniques utilized by participants to increase the effective impact of Master Gardeners. Share highlights from three approaches implemented at Clemson, University of Georgia, and Alabama Cooperative Extension Service to utilize Master Gardener service more effectively.

If Extension is to continue to meet the demand for home horticulture information, Master Gardeners are the logical choice to help “pick up the slack” due to continued streamlining of Extension Service budgets and personnel. The goal of this workshop is to determine effective techniques to accomplish this and provide a forum to share these ideas. Workshop participants will be divided into groups and given a charge to determine ways to increase effectiveness of Master Gardeners based on their experiences with their Master Gardener programs. Each group will then report and share these techniques with the entire group.

4:00–4:10 pm

### **Advanced Training for Master Gardeners to Expand Outreach in Urban Forestry and Urban Water Issues**

Ellen Bauske\*

UGA, Griffin, GA; ebauske@uga.edu

4:10–4:20 pm

### **Master Gardener Helpline: A Success Story**

Kerry Smith\*

Alabama Cooperative Extension Service, Auburn University, AL; smithkp@auburn.edu

4:20–4:30 pm

### **Master Gardener Online Program for Activities and Impact Reporting**

Timothy S. Davis\*

Clemson University, Columbia, SC; tdvs@clemson.edu

**Monday, August 2, 2010**

**Springs A & B**

**Workshop 5:**

## **Developments and Outlook for Mechanization of Vegetable, Fruit, and Nut Production**

Sponsor: Production and Harvest Mechanization (MECH) Working Group

Coordinator(s) Stephanie Walker, swalker@nmsu.edu; Rod Reed, rod.reed@kemin.com

**Objective:** The history and future progress in mechanization technology for selected fruit and vegetables will be presented.

Efficient mechanical harvest of vegetable, fruit and nut crops is critical to the long term viability of many agricultural industries. Collaboration between horticulturalists, physiologists, breeders, as well as engineers is critical to the successful transition to mechanized systems. Experts will present current information on equipment development, crop management and breeding strategies developed in union to successfully transition to mechanized crop production.

4:00–4:30 pm

### **History of Mechanized Harvesting of Processing Tomatoes in California**

Gene Miyao\*

UC Cooperative Extension, Woodland, CA; emmiyao@ucdavis.edu

Bruce R. Hartsough

U. of California, Davis, CA; brhartsough@ucdavis.edu

Mechanization of California’s processing tomato crop was hastened by the phase out of the Bracero agricultural labor program ending by 1964. Decades earlier, UC Davis plant breeder Jack Hanna had the insight to begin selecting for plant horticultural characteristics that included a determinant vine type with a concentrated fruit set and more durable fruit to withstand the bruising mechanical handling. By 1949, the breeding program was partnered with efforts by UCD Agricultural Engineer Coby Lorenzen and colleagues to design a prototype, once-over harvester.

Prior to mechanization, tomatoes were hand picked into wooden boxes each containing about 50 lb of fruit. Fields were commonly harvested multiple times as vines had indeterminate growth. Even with continuous setting fruit, average production was below 20 tons per acre. To hand harvest 75 tons per day, a 30-person crew of efficient, durable workers was needed. The first commercial mechanical harvester was showcased in 1960 by Blackwelder under a patent agreement with UCD. Over a dozen sorters manned the first harvesters. The crew was capable of harvesting 75 tons of fruit per 10-hour day. Since the crew rode on the machine and worked under a shade structure, the

labor force included women and older teenagers as well. Fruit were harvested into wooden bins that held over 1000 lb of fruit.

Current harvest machines include electronic sorters to remove dirt clods and under-colored fruit, have aggressive shaker systems to remove fruit from vines and require less maintenance. In California, the sole remaining harvester manufacturer is California Tomato Machinery that has patents from former major manufacturers Johnson, Blackwelder and FMC. Machine harvest output increased to over 75 tons per hour under ideal conditions, but can easily average 25 tons per hour over the season. Harvest output also increased with the addition of a night crew from a traditional day-only shift. Sorter crews have been reduced to about 2 to 4 persons per machine. Fruit is harvested into 25,000-lb capacity tubs set directly on tandem trailers for highway transport.

What's in the future? Electronic sorting will likely advance to detect an array of fruit defects. Perhaps pickup mechanisms might change to be similar to small grain stripper headers where only grain is collected, without high volumes of plant debris. Changes may be needed to adjust to modifications from conservation tillage and sustainable agricultural practices.

Improvements in harvesting efficiency will continue to be coupled with improvements from plant breeding programs.

4:30–5:00 pm

### **Pepper Harvest Mechanization: Past and Present**

Paul A. Funk\*

USDA-ARS-Southwestern Cotton Ginning Research  
Laboratory, Mesilla Park, NM; pfunk@nmsu.edu

Peppers (*Capsicum spp.*) include a diverse collection of cultivars produced for a wide variety of end uses. Labor for hand harvest is as much as half of the cost of production. There have been attempts to mechanize pepper harvest since 1965, yet many segments of the industry still depend on hand labor - which is becoming increasingly expensive and scarce. Over fifty articles covering forty-five years of research and development pertaining to pepper harvest technology were reviewed. Prior efforts resulted in mechanical harvest technology for select cultivars. Mechanization adoption has been slow for several reasons: many markets require a product free of pedicels and calyxes, and destemming has not yet been automated; fruit size and shape varies greatly between cultivars, and harvest timing and fruit succulence varies by end use, so no one machine can pick and clean all types effectively; and labor is still cheap available in other parts of the world where peppers can be produced. Plant breeding objectives and crop production practices resulting in tough, round fruit dispersed high on a single stalk would facilitate mechanization. The ideal harvester would be both aggressive enough to remove all fruit and gentle enough to damage none while also completely separating leaves and branches. Processing plant modifications would include color sorting and destemming machinery. Describing where pepper harvesting technology has been, what major breakthroughs have

occurred, and what is the current status of the science equips researchers in various disciplines with the basic understanding needed to make advances in their respective fields that will facilitate pepper harvest mechanization.

5:00–5:30 pm

### **Development of Mechanical Harvesting of California Olives**

Louise Ferguson\*

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Uriel Rosa

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Sergio Castro-Garcia

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S.M. Lee

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J.X. Guinard

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Mechanical harvesting must be developed for successful table olive production in California. Both canopy contact shaking head and trunk shaking harvesters can produce processed black ripe 'Manzanillo' olives that neither trained sensory panels nor consumer panels could distinguish from hand-harvested olives. However, both types of harvesters remove and capture less than the 80% efficiency required for economically feasible mechanical table olive harvesting. The harvesters differ in their removal patterns, efficiency, and types of tree damage. No successful abscission compounds to decrease fruit removal force have been identified. Therefore, as with oil olives, the tree shape must be modified for successful mechanical table olive harvesting. Recent results demonstrate training to an espalier shape, with and without a trellis, in high density hedgerows, does not decrease yield. These espaliered hedgerow orchards can be harvested with both canopy contact and trunk shakers. Therefore, the traditional California table olive industry must adapt a modified version of the high density and super high density orchards, designed specifically for mechanical harvesting, now being developed for olive oil production in California.

5:30–6:00 pm

### **Mechanization Systems for Vineyards**

Bernd Maier\*

New Mexico State University, Las Cruces, NM;  
bernaier@nmsu.edu

Over the last 20 years the Southwest region of the United States has seen an increased interest in viticulture. Sizable vineyards have been planted in West Texas, New Mexico, Colorado and Arizona. In a time when trained field labor is in short supply many growers look at mechanization to overcome the labor shortage. The two most labor intensive tasks in a vineyard are winter pruning and harvest. Mechanization of winter pruning has been pioneered over the last decade and still needs much improvement to be adopted widely. Mechanical harvesting, in

contrast to mechanical pruning, is now an accepted method. The advantages of mechanical harvest in the dry hot southwestern desert climate outweigh any shortcomings. The window to pick a particular grape variety may only be a few days. With the shortage of labor, one harvest machine may be able to replace 30 to 40 workers. However, the larger advantage for the wine-maker using mechanically harvested fruit is the much cooler fruit. Night harvested fruit might be 30 to 40 F\* cooler than day harvested fruit thus suppressing much of the wild yeast fermentation activity before the harvested grapes arrive at the winery for processing.

**Monday, August 2, 2010**

**Desert Salon 1-3**

**Workshop 6:**

## **Reducing Water Quality Impacts from Horticultural Crop Production**

Sponsor: Industry Division

Coordinator: Monica P. Ozores-Hampton, ozores@ufl.edu

**Objective:** To familiarize the audience with the challenges that water quality regulation poses for horticultural producers around the country, and inform them of efforts underway to develop and encourage the adoption of more environmentally conscious production practices.

The Clean Water Act of 1972 requires that States assess the impact of non-point sources of pollution on surface and ground water, and establish programs to minimize any adverse environmental impact. Environmental monitoring has shown elevated nitrate concentration to be widespread in both surface and groundwater, often occurring in regions with concentrated horticultural production. In a number of states regulation of farming practices is under consideration to reduce nitrate loads in the environment, and these regulations have the potential to severely disrupt horticultural production” result in significantly changed horticulture production practices

4:00–4:15 pm

### **Agriculture and the Clean Water Act**

Jovita Pajarillo\*

USEPA., San Francisco, CA; pajarillo.jovita@epa.gov

4:15–4:30 pm

### **Development of Vegetable BMPs (Best Management Practices) to Reduce Pollutant Loads in Targeted Florida Watershed**

Monica P. Ozores-Hampton\*

Univ of Florida, Immokalee, FL; ozores@ufl.edu

4:30–4:45 pm

### **Strategies for Reducing Nitrate Leaching from Center Pivot Irrigated Potatoes in Minnesota**

Carl J. Rosen\*

Univ of Minnesota, St Paul, MN; rosen006@umn.edu

4:45–5:00 pm

### **Reducing the Environmental Water Quality Impact of California Lettuce Production**

Timothy K. Hartz\*

University of California, Davis, CA; tkhartz@ucdavis.edu

5:00–5:15 pm

### **Improving Onion Production while Reducing Nitrate Loading**

Clinton C. Shock\*

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Erik B.G. Feibert

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Phil Richerson

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Onion is an economically important crop in southeastern Oregon and southwestern Idaho. Onion is grown in rotation with corn, wheat, sugar beet, potato, bean, and other crops. Traditionally, onion production was under furrow irrigation using heavy inputs of water and nitrogen (N) fertilizer. By 1987 the groundwater in Northeastern Malheur County, Oregon, had become contaminated with nitrate and residues of the herbicide DCPA. An official groundwater management area was established by the Oregon Department of Environmental Quality along with an action plan and well monitoring network. The action plan allowed for a trial period of years to see whether voluntary changes would improve contamination trends. Researchers, producers, and agencies cooperated to develop production options that had the possibility of being both environmentally protective and cost effective. Options to improve irrigation practices, increase N fertilizer use efficiency on several rotation crops, and find a cost effective replacement for DCPA were tested. Irrigation research demonstrated the opportunity for increased onion productivity through both irrigation scheduling and adoption of drip irrigation. Fertilization research demonstrated that N applications were more efficient with different timings and in smaller increments. Lower cost herbicides could replace DCPA. Research results were effectively delivered through many means and voluntarily adopted. Both groundwater nitrate and DCPA residues are declining. Onion productivity has increased.

5:15–5:30 pm

### Florida's Programs to Address TMDLs and Their Impact on Fruit, Nut, and Ornamental Crop Production Practices

Brian Boman\*

University of Florida, Fort Pierce, FL; bjbo@ufl.edu

5:30–5:45 pm

### Grower Adoption of More Environmentally Sound Fertilization Practices in California Fruit and Nut Orchards

Scott Johnson\*

Kearney Ag Center, Parlier, CA; sjohnson@uckac.edu

Tuesday, August 3, 2010

Springs D &amp; E

#### Workshop 7:

## Alternative Energy Sources for Controlled Environment Agriculture Systems

Sponsor: Growth Chambers and Controlled Environments (CE) Working Group

Coordinator: Carl E. Sams, carlsams@utk.edu

**Objective:** Objective: In this workshop participants will discuss the current status of energy use in controlled environment agriculture systems and explore alternative energy options for use in commercial systems. The emphasis will be on open discussion of current and alternative energy sources with the hope of developing strong teams that will be successful in solving future energy problems facing horticultural industries.

Four speakers will present 1–3 PowerPoint slides each on a selected topic related to energy use in controlled environment agriculture systems. These topics may include geothermal, bio-fuel, solar, and other alternatives to current energy sources. Speakers will be limited to 5 minutes to present a topic that will then be open to group discussion of status, efficiency, feasibility (from an energy perspective) and economic practicality. In addition to the six speakers, all interested participants were encouraged to submit 1–3 slides on an energy-related subject or system of their choice to the moderator (carlsams@utk.edu) prior to the conference. Up to six of these submissions will also be included in the workshop as discussion points. The moderator will organize the submitted discussion points into groups and email the discussion leaders as to the order of the discussion before the conference. At least half of the workshop time will be committed to active discussion among all participants. The intent is to: 1) familiarize participants with the breadth of alternative energy sources currently being evaluated; 2) to encourage working group members to build relationships that will foster research, education and extension team-building for

future cooperative projects; and 3) develop timely topics to be presented in detail in a future colloquia on alternative energy systems for controlled environment agriculture.

Tuesday, August 3, 2010

Springs D &amp; E

#### Workshop 8:

## Life after Graduation

Sponsor: Graduate Student (GRAD) Working Group

Coordinator(s): Amanda J. Hershberger, ajhershb@uga.edu; Sarah Potts, smanthey@illinois.edu

**Objective:** To present current students with possible careers they may obtain after graduation. This workshop will provide information regarding careers in academia, government, or industry.

This workshop will provide information to current graduate students about careers they may obtain after graduation. This will be useful to a range of students, including those interested in ceasing their graduate careers after obtaining their MS, to those continuing on to complete their PhD. We will be hosting representatives from academia, industry, and governmental entities. The category of academia will be represented by department heads and existing professors, including those early in their careers. Industry representatives cover a range of research disciplines. Governmental representatives will include those from USDA and public horticulture. We will be providing a somewhat informal presentation process with each category assigned stations. Each station will be given a specific time allotment to present helpful advice and ways in which students may obtain careers in their field. This will occur during the first hour and 15 minutes. The last 45 minutes will allow students to approach representatives for one-on-one conversation. Although this session is directed toward graduate students, everyone is welcome to participate in this useful workshop!

Tuesday, August 3, 2010

Springs H &amp; I

#### Workshop 9:

## Local Food Systems—Horticulturists' Roles in Infrastructure Development

Sponsor: Local Food Systems (LOCSYS) Working Group

Coordinator(s): Matthew D. Kleinhenz, kleinhenz.1@osu.edu; Curt R. Rom, crom@uark.edu

**Objective:** Provide a forum through which participants will: 1) be exposed to balanced perspectives on the opportunities and limitations associated with the advancement of local food systems, 2) become familiar with examples of successful lo-



calization (e.g., resources, process, impacts), 3) strengthen and establish collaborations, and 4) identify specific steps available to ASHS and its stakeholders for eliminating resource gaps within local food systems.

Reducing the distance between sites of food production and consumption is regarded by many as fundamental to personal and collective well-being. Localizing food supplies and consumption is regarded as resource efficient, integral to enhancing the positive role of food and diet in human health, and an economic engine. Localization often employs natural and other models of resource procurement, handling and distribution. This approach helps localization to be adaptable to a range of conditions, scalable in terms of targets for the amount of food consumed within a geographic area being produced in the same area and replicable on a wide scale. While local food systems are increasing in number and impact, many recognize significant obstacles to their advancement. For example, current inherent production capacities vary at all geographic scales due to seemingly unalterable factors. Fluctuating seasonal abiotic conditions disrupt production in nearly every area at some time each calendar year and population and land availability have a number of potentially negative on- and off-farm effects on system capacity. Also, off-farm distribution, marketing and other factors can limit consumer access to local farm products. And, the knowledge base required to initiate and strengthen local food systems is deficient. This deficiency is opportunity for professional horticulturists as they continue to have key roles in addressing major questions related to the structure and function of future food systems, especially local ones. This workshop is an interactive forum through which participants will: 1) be exposed to balanced perspectives on the opportunities and limitations associated with the advancement of local food systems, 2) become familiar with examples of successful localization (e.g., resources, process, impacts), 3) strengthen and establish collaborations, and 4) identify specific steps available to ASHS and its stakeholders for eliminating resource gaps within local food systems. Invited presentations will be complemented by open, facilitated discussion on issues related to the potential establishment of an efficient and responsive local food systems-specific research, extension and teaching infrastructure. The discussion is expected to cover topics such as supply-demand discrepancies (including seasonality and distribution), local-scale appropriate methods, technology, regulation and policy, and research-extension-teaching program resource procurement. Speakers, topics, and procedural details of the workshop will be set in part based on input obtained via social networking portals, including those managed by ASHS.

**Tuesday, August 3, 2010**

**Desert Salon 4-6**

**Workshop 10:**

**SCRI Project Directors Workshop**

Sponsor: SCRI

Coordinator: Thomas A. Bewick, [tbewick@csrees.usda.gov](mailto:tbewick@csrees.usda.gov)

**Objective:** This workshop will overview the grant process and methods for success.

2:00–2:15 pm

**Using Planning Grants to Build Partnerships among Scientists and Stakeholders**

Kathleen Kelly\*

USDA, Washington DC, DC; [tbewick@nifa.usda.gov](mailto:tbewick@nifa.usda.gov)

2:15–2:30 pm

**Developing a Community of Practice for SCRI Funding**

Eric T. Stafne\*

Oklahoma State University, Stillwater, OK;  
[eric.t.stafne@okstate.edu](mailto:eric.t.stafne@okstate.edu)

2:30–2:45 pm

**Transitioning from AFRI to SCRI Funding**

Amy Lezzoni\*

Michigan State University, East Lansing, MI; [iezzoni@msu.edu](mailto:iezzoni@msu.edu)

2:45–3:00 pm

**Building Infrastructure to Support Regional Systems for Specialty Crops**

Casey Hoy\*

USDA, Washington DC, DC; [tbewick@nifa.usda.gov](mailto:tbewick@nifa.usda.gov)

3:00–3:15 pm

**Delivering Impact for Stakeholders within the Project Period**

Sanjiv Singh\*

Carnegie Mellon University, Pittsburgh, PA; [ssingh@ri.cmu.edu](mailto:ssingh@ri.cmu.edu)

Tuesday, August 3, 2010

Springs K &amp; L

Workshop 11:

## Horticultural Value of Wild Genetic Resources

Sponsor: Genetics and Germplasm (GG) Working Group

Coordinator: Gayle Volk, gvolk@lamar.colostate.edu

**Objective:** 1. Identify the value of using wild genetic resources in breeding/research programs 2. Provide examples of highly successful plant expeditions 3. Uses of wild relatives of horticultural crops in genomics

Wild plant genetic resources are increasingly becoming valuable for breeding, genomics, and ornamental horticulture programs. Wild relatives of horticultural species may offer desirable traits that are not available in cultivated varieties, but wilds often also have traits that are highly undesirable. Advances in comparative genomics and marker-assisted breeding facilitate the inclusion of the valued traits from wild materials in plant breeding programs. As technologies advance, wild plant genetic resources will become even more valuable for future research developments. Our presenters include plant explorers who have traveled throughout the world to identify novel and representative plant materials, often for inclusion in the USDA-ARS National Plant Germplasm System collections. The speakers will highlight the novelty and diversity illustrated by wild materials. Importantly, they will show how these materials, some of which may exhibit less-than-desirable characteristics, are providing key genes for horticultural improvement. The presenters will provide information on explorations that can be immediately used to excite and engage students in horticulture classes.

4:00–4:20 pm

### Collecting in Central Asia: National Plant Germplasm System Plant Explorations

Barbara Hellier\*

USDA ARS, Pullman, WA; bhellier@wsu.edu

The USDA-ARS National Plant Germplasm System is charged with the preservation of economically important crop plants and their wild relatives. Curators in the System strive to develop collections capturing the genetic diversity of each species. One mechanism for filling gaps in collections is through plant exploration. The process of NPGS plant germplasm exploration will be discussed using examples from collection missions in Central Asia. The 2007 exploration for *Taraxacum kok-sagys* will be used as a specific case study.

4:20–4:40 pm

### From Villous Strawberry Shams to Hairy Huckleberries: The Wild Side of Berry Exploration

Kim E. Hummer\*

USDA ARS, Corvallis, OR; Kim.Hummer@ars.usda.gov

The U.S. Dept of Agriculture (USDA), Agricultural Research Service, National Clonal Germplasm Repository in Corvallis was established as the U.S. berry genebank in 1981. Since then the USDA has sponsored numerous exploration missions throughout the U.S. and in foreign countries to obtain berry plant genetic resources. Species of *Fragaria* (strawberries), *Ribes* (currants and gooseberries), *Rubus* (raspberries and blackberries) and *Vaccinium* (blueberries and cranberries) have native domestic and international distributions. With limited gene pools for cultivated strawberries, raspberries, and blackberries these expeditions have provided a wealth of genetic resources to expand breeding approaches. With the diverse species inherent in the development of the cultivated blueberry, these trips have discovered unusual blueberry relatives and forms available for expanding the production range, increasing plant yields, and improving antioxidant content of the berries. Along the way, new fruit species and new uses for known species were observed. Sharing the bounty of the world's berries include fauna from snakes, bears, and bison, to butterflies, mosquitoes, ticks, and chiggers. Avenging *Toxicodendron* diversity add their mark on intrepid explorers. Remote sites with nothing but clear night stars and the satellite markers on the global positioning system (GPS) offer radiant beauty and an abiding hope for the conservation of plant genetic diversity for all people for all time.

4:40–5:00 pm

### The Collecting, Use, and Conservation of Tropical Fruit Genetic Resources

Richard J. Campbell\*

Fairchild Trop Gardens Res Ctr, Miami, FL;  
rcampbell@fairchildgarden.org

Fairchild Tropical Botanic Garden has been active in the collection, use and conservation of tropical fruit genetic resources with the formation of the Tropical Fruit Program in 1987. Currently we focus on mango (*Mangifera indica*) and its relatives, West Indian avocado (*Persea americana* var *americana*), jackfruit (*Artocarpus heterophyllus*), mamey sapote (*Pouteria sapota*) and its relatives, sapodilla (*Manilkara zapota*), canistel (*Pouteria campechiana*), abrico (*Mammea americana*), tamarind (*Tamarindus indica*) and Spanish lime (*Melicoccus bijugatus*). This work outlines the unique nature of each of these genetic collections, the collecting of material and the way in which each collection is managed and used. Collecting and use strategies have been designed to allow for cost effective conservation strategies in South Florida and with satellite collections within the United States and outside of our borders. The size

of each collection, genetic and horticultural objectives, data collection and field maintenance are catered to each crop. All collections are integrated fully into the mission and activities of the public garden, even though most are physically grown at separate locations.

5:00–5:20 pm

### Use of Native Potatoes for Research and Breeding

John Bamberg\*

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Alfonso del Rio

USDA-ARS, Sturgeon Bay, WI; adelrioc@wisc.edu

Potato is an important world crop with an abundant diversity of wild relatives for research and breeding. About 200 tuber-bearing *Solanum* relatives of the cultivated potato occur naturally from southern Chile to the southwest USA. Only five of these have been reported in the USA, and only two exist with certainty (*S. fendleri* and *S. jamesii*). The authors and colleagues have conducted expeditions in the southwest USA each season since 1992, collecting nearly 200 new germplasm samples. This work has greatly improved the representation of these species in the genebank with respect to geography and genetic diversity available to germplasm users worldwide. Corrected or refined collection site information now makes it possible to easily find these typically small populations for continued *in situ* study and sampling. Collecting experiences, often in contrast with conventional wisdom have been documented for the benefit of future collectors. A broader sampling of the region has allowed studies of the association of eco-geo parameters with patterns of genetic diversity in an attempt to predict “hot spots” of diversity for future expeditions. Evaluation of these materials has resulted in the discovery of new useful traits—novel mutants, disease and pest resistances, and human nutritional compounds. Finally, these materials have been deployed as research models in numerous experiments to assess how collecting and preservation techniques impact the status and dynamics of genetic diversity in potato genebanks.

5:20–5:40 pm

### New Carrot and Garlic Germplasm to Advance Breeding and Understand Crop Origins

Philipp W. Simon\*

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David Spooner

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The genetic variation provided by diverse plant germplasm is the basic building material used for crop improvement that shapes the crops we grow today. Wild carrot from the U.S. provided the cytoplasm used to develop a reliable system to produce hybrid carrots that account for most of the commercial production in the U.S. and Europe today. Diverse locally grown carrot cultivars

and land races from South America, Europe, the Middle East, and Asia provides genetic variation being incorporated into carrot breeding programs today for nematode resistance and nutritionally important carotenoid and anthocyanin pigments. Garlic germplasm collections from Central Asia have been a valuable source of genetic variation used to improve garlic so it can be bred like any seed-propagated crop. Wild garlic germplasm from Central Asia and carrot germplasm from North Africa is providing valuable insights into the systematics and origins of these crops. A diverse collection of carrot and garlic germplasm has been essential to drive the improvement and broaden our understanding of these crops, and promises to be even more valuable in the future.

5:40–6:00 pm

### The Value of Wild *Theobroma* Germplasm in Genomics

Raymond J. Schnell\*

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Traditional *Theobroma cacao* (cacao) breeding has only been marginally successful in improving bean yields and disease resistance. A little over 10 years ago, a Marker-Assisted-Selection (MAS) program was developed for cacao and MAS has significantly increased the rate of genetic gain. Whole genome sequencing is strategic for high value crops and having the complete genome sequence greatly enhances MAS. Cacao is going through a transition from specialty crop to more mainstream crop due in part to the cacao genome-sequencing project, a collaboration of Mars, Inc., USDA-ARS and IBM, begun in June, 2008 ([www.cacaogenomedb.org](http://www.cacaogenomedb.org)). A combination of Sanger, 454, and Illumina sequencing methodologies are being used along with a complete physical map. In spite of the major advances in cacao genomics, there are still few mapping populations or natural populations to either study or use for sources of disease resistance, unique flavors or yield traits. *Theobroma grandiflorum* (cupuassu) is a closely related species with similar physiology and self-incompatibility system. The seeds, when fermented, taste different from cocoa and are not used to produce chocolate. Cupuassu is susceptible to *Moniliophthora perniciosa*, the causal agent of witches' broom disease in cacao; however, isolates that infect cacao do not infect cupuassu. A population of interspecific hybrids between *T. cacao* and *T. grandiflorum* is being developed. These will segregate for many horticultural traits including witches' broom resistance. The evaluation of these interspecific hybrids and the potential contribution to understanding distinct patterns of gene expression and how this will contribute to cacao breeding will be discussed.

**Tuesday, August 3, 2010****Springs D & E****Workshop 12:****Innovations in Packaging**

Sponsor: Postharvest (PH) Working Group

Coordinator: Penelope Perkins-Veazie, [penelope\\_perkins@ncsu.edu](mailto:penelope_perkins@ncsu.edu)

**Objective:** 1. Learn about advances in packaging 2. What are industrial challenges, such as the sustainability goals of box stores 3. What is new in edible and biodegradable packaging 4. What are concerns with packaging, such as atmospheric challenges, food safety issues

Packaging is widely used in many postharvest and food science applications, including bags, clamshells, and wraps. A number of issues surround packaging manufacture and choices, including atmospheric changes, migration of contaminants, carbon footprint, biodegradation and edibility. We now have to think beyond packaging for shelf life extension and start considering sustainability and toxicity when choosing packages. The purpose of this workshop is to bring research and extension specialists up to date on the dynamic roles of packaging at the analytical, consumer, and industrial levels.

**Wednesday, August 4, 2010****Springs H & I****Workshop 13:****Fresh Produce Safety: A National Perspective**

Sponsor: Vegetable Crop Management (VCM) Working Group

Coordinator: Kurt Nolte, [knolte@ag.arizona.edu](mailto:knolte@ag.arizona.edu)

**Objective:** This workshop is designed to provide a forum for discussing current issues and future trends in fresh produce safety.

8:00–8:30 am

**Fresh Produce Safety: A National Perspective**

Kurt D. Nolte\*

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Wesley L. Kline

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Charles A. Sanchez

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Keith R. Schneider

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Consumer demand for ever-increasing amounts of minimally processed fresh produce can run the risk of being contaminated by

pathogens which can, in some cases, make consumers seriously ill. The loss of public confidence associated with food recalls and outbreaks of infectious diseases associated with food-borne microorganisms can be devastating and vegetable producers are genuinely and desperately interested in halting outbreaks. The sheer scope of the 2006 spinach outbreak was undeniable (spinach growers alone suffered \$200 million in lost sales). In light of this and later outbreaks in tomatoes and melons, the U.S. Food and Drug Administration recently (2009) published three draft documents outlining guidance strategies designed to help growers and others across the entire supply chain minimize or eliminate microbial contamination in tomatoes, leafy greens, and melons. The commodity specific guidelines (CSGs) are intended for growers, packers, processors, transporters, retailers, and others throughout the supply chain and provide a framework for identifying and implementing appropriate measures to minimize the risk of microbial contamination of tomatoes, leafy greens, and melons. This workshop will explore the current status of fresh produce safety from the standpoint of key food production and handling safeguards presently in place, to the future transformations driven, partially, by developments in the food industry, federal and state regulation. Consequently, the program will involve a review of the current fresh produce safety outreach methods and clarify the need for additional research within programs which target the safe production and handling of fresh produce.

8:30–9:00 am

**Current Food Safety Outreach in the Mid-Atlantic and New England States**

Wesley L. Kline\*

Millville, NJ; [wkline@rce.rutgers.edu](mailto:wkline@rce.rutgers.edu)

9:00–9:30 am

**Current Needs in U.S. Leafy Green Research and Outreach Programming**

Charles A. Sanchez\*

Univ. of Arizona, Yuma, AZ; [sanchez@ag.arizona.edu](mailto:sanchez@ag.arizona.edu)**Wednesday, August 4, 2010****Springs D & E****Workshop 14:****RosBREED: Enabling Marker-assisted Breeding in the Rosaceae**

Sponsor: Fruit Breeding (FRBR) Working Group

Coordinator: Amy Iezzoni, [iezzoni@msu.edu](mailto:iezzoni@msu.edu)

**Objective:** In September, the USDA-SCRI program awarded a grant that seeks to increase the breeding efficiency of Rosaceous species. This project entitled “RosBREED: Enabling marker-assisted breeding in the Rosaceae” involves four crop groups, apple, strawberry, peach and cherry, and 12 breeders. We are very interested in extending the reach of our project to other rosaceous crop breeders who are not in our grant and fruit

breeders in general. As the first translational genomics CAP project funded for a fruit crop family, our project would provide non-rosaceous crop breeders insight into how one diverse plant community came together to embrace our crop diversity (and polyploid complexity) and move forward with a common goal. Our RosBREED team would appreciate the opportunity to present a Workshop at ASHS sponsored by the Fruit Breeding Working Group, to help us engage the wider fruit breeding community. Complete details of our project can be found at [www.rosbreed.org](http://www.rosbreed.org)

The Rosaceae family (including apple, peach, sweet and tart cherries, and strawberry) provides vital contributions to human health and well-being, and collectively constitutes the economic backbone of many U.S. rural communities. Rosaceae genetics and genomics are developing rapidly but have not been translated to routine practical application. RosBREED will create a national, dynamic, sustained effort in research, infrastructure establishment, training, and extension for applying marker-assisted breeding (MAB) to deliver improved plant materials more efficiently and rapidly. Specific objectives are to: (1) enhance the likelihood of new cultivar adoption, enlarge market potential, and increase consumption of rosaceous fruits by using socio-economic knowledge of stakeholder values and consumer preferences to inform breeding; (2) establish sustainable technical infrastructure for an efficient MAB Pipeline in Rosaceae, including crop-specific SNP genome scan platforms for breeding-relevant germplasm exploiting the shared ancestry of Rosaceae crops; (3) integrate breeding and genomics resources by establishing a user-friendly U.S.-wide standardized statistical framework and breeding information management system; (4) implement MAB in core RosBREED breeding programs with a common focus on fruit quality traits; and (5) enhance sustainability of cultivar development by transferring MAB technologies to the public and private community of U.S. Rosaceae breeders through training current and future breeders as well as engaging the production, processing and marketing sectors, allied scientists, and consumers. RosBREED funding is provided from the USDA-SCRI, award number 2009-51181-05808.

8:00–8:20 am

### **RosBREED Project Overview**

Amy Iezzoni\*

Michigan State University, East Lansing, MI; [iezzoni@msu.edu](mailto:iezzoni@msu.edu)

8:20–8:40 AM

### **RosBREED Core Breeding Programs: Goals and Future Impacts**

J. J. Luby\*

Univ of Minnesota, St. Paul, MN; [lubyx001@umn.edu](mailto:lubyx001@umn.edu)

8:40–9:00 AM

### **Utilizing Socioeconomic Knowledge of Stakeholder Values and Consumer Preferences to Inform Breeding**

Chengyan Yue\*

Univ of Minnesota, St Paul, MN; [yuechy@umn.edu](mailto:yuechy@umn.edu)

9:00–9:20 AM

### **Bridging the Chasm between Genomics and Breeding: Enabling Marker-assisted Breeding**

Cameron Peace\*

Washington State University, Pullman, WA; [cpeace@wsu.edu](mailto:cpeace@wsu.edu)

9:20–9:40 AM

### **Transferring Marker-assisted Breeding Capabilities to the Public and Private Community of U.S. Rosaceae Breeders**

Cholani Weebadde\*

Michigan State Univ, East Lansing, MI; [weebadde@msu.edu](mailto:weebadde@msu.edu)

Wednesday, August 4, 2010

Springs A & B

### **Workshop 15:**

## **The Role of Horticulture in Managing Plant Invasiveness and Reducing New Invasive Introductions in the U.S.**

Sponsor: Nursery (NUR) Working Group)

Coordinator(s): Jyotsna Sharma, [jyotsna.sharma@ttu.edu](mailto:jyotsna.sharma@ttu.edu); Jim Owen, [jim.owen@oregonstate.edu](mailto:jim.owen@oregonstate.edu)

**Objective:** 1. To facilitate a discussion and exchange of ideas on the role of horticulture in plant invasiveness in the U.S. via structured presentations followed by a panel discussion. 2. To discuss in detail: (1) a history of plant invasiveness in the U.S., (2) terminology associated with invasive plants, (3) breeding methods to reduce the invasive potential of nursery crops, and (4) current approaches for managing invasive plant populations. 3. To engage in an open discussion with the panelists including invasive plant researchers and specialists from academia, government, and industry.

The plant and nursery industries in the U.S. are intricately involved in all aspects related to introduction, management, and handling the consequences of plants that have become invasive or may have the potential to become invasive. With plant invasiveness rapidly becoming an economic and ecological

challenge, there is a constant need for updating the plant industry personnel on the latest information on science and technology for preventing, managing, or reducing invasive plants. Our workshop is designed to bring together researchers, specialists, regulators, and stakeholders to discuss the role of plant industries in managing invasive plants in the U.S.

8:00–8:20 am

### **History of Plant Invasiveness**

Richard T. Olsen\*

U.S. National Arboretum, Washington, DC; richard.olsen@ars.usda.gov

Weed species, invasive or otherwise, have advanced lock-step with the rise of agriculture and the advancement of human cultures. In North America, the introduction of exotic species began with the first colonists and continued unabated with the rise in global trade. So what changed late in the 20<sup>th</sup> century to explain the meteoric rise in the science of biological invasions? Have scientific advancements in ecology shown us a new path? Have urban sprawl and habitat fragmentation left a void to be filled by an opportunistic cultivated flora? Has there been a significant evolution in values that competes with objective science and politicizes invasive species, turning the very act of cultivating plants into a series of moral judgments? Plants originally cultivated for ornament are prime targets, as they are often viewed as having the least value but the highest risk in invasive risk cost-benefit scenarios.

8:20–8:40 am

### **Invasive Plant Terminology**

James Altland\*

USDA-ARS, Wooster, OH; james.altland@ars.usda.gov

The nursery and landscape industries are often viewed as major pathways for introduction of invasive plants. Whether this recognition is deserved or not, states and government entities are passing restrictive legislation. The horticultural industry should be proactive in dealing with invasive plant issues before legislation forces them into undesirable programs or practices. One of the problems facing the horticulture industry is the lack of a consistent and accurate terminology to describe invasive plants. Ecologists have been debating invasive terminology for many years. They still do not agree precisely what constitutes a native plant, much less what constitutes an invasive plant. In the interest of promoting uniformity of language in the business of nursery crop production, the following terminology is recommended for the United States. Use the term native to describe plants that naturally occurred in a particular habitat or region prior to Euro-American settlement. Use the term non-indigenous species (NIS) to describe plants that are not native. Avoid using the term alien, as this and similar terms have been viewed as racist. Use the term invasive to describe populations of plants that

produce reproductive offspring, often in very large numbers, and distribute those offspring at considerable distances from parent plants and thus have the potential to spread over a considerable area and cause economic or environmental impact. Avoid using the term noxious. Noxious is not an ecological description, but a label applied by government and other entities whose criteria vary greatly.

8:40–9:00 am

### **Breeding Methods to Reduce the Invasive Potential of Nursery Crops**

Ryan Contreras\*

Oregon State University, Corvallis, OR; ryan.contreras@hort.oregonstate.edu

Legislation to restrict production and sale of economically important nursery crops considered invasive is being proposed and enacted in numerous states. The estimated value of nursery crops considered invasive is in the hundreds of millions. In addition to the economic impact, these plants often fill a niche in the urban landscape by growing well under strong abiotic pressure and exhibit resistance/tolerance to pests and diseases that native species have difficulty withstanding. As a result, it is important to develop forms that have reduced fecundity, which will allow growers to market forms of these hardy, non-native species without the danger of causing economic or environmental harm. Techniques to develop forms with reduced fertility such as ploidy manipulation, interspecific hybridization, mutagenesis, and combinations of thereof will be discussed.

9:00–9:20 am

### **Current Approaches for Managing Invasive Plant Populations**

Robert Leavitt\*

California Department of Food and Agriculture, Sacramento, CA; rleavitt@cdfa.ca.gov

The California Department of Food and Agriculture (CDFA) is charged with identifying, preventing, eradicating and controlling invasive plants, also known as noxious weeds. This includes preventing their entry into the state at the border protection stations. It also includes preventing the artificial spread of noxious weeds in horticultural crops by regulation. The CDFA works with county agricultural commissioners, cooperative weed management areas, and other agencies and partners to control and eradicate noxious weeds. The CDFA is an active member of the California Horticultural Invasive Prevention partnership and the works with PlantRight campaign to encourage the voluntary removal of noxious weeds from horticultural production.

**Wednesday, August 4, 2010****Desert Salon 1-3****Workshop 16:****Examining the 4R Concept of Nutrient Management: Right Source, Right Rate, Right Time, Right Place**

Sponsor: Plant Nutrient Management (PNM) Working Group

Coordinator: John D. Lea-Cox, jlc@umd.edu

**Objective:** The International Fertilizer Industry Association (IFA) has is promoting the Global '4R' Nutrient Stewardship Framework, designed to facilitate the development of site- and crop-specific fertilizer best management practices, based on sound science. This workshop will expose participants to this concept and allow for the discussion of the issues associated with the adoption of these nutrient management practices.

This workshop will focus on the 4R concept of nutrient management, whose principles can be applied to both organic and inorganic fertilizer sources. This concept can help farmers and the public understand how best management practices for fertilization contribute to agricultural sustainability goals. Goals for economic, environmental and social progress are set by, and reflected in performance indicators which have been validated by research, and are then chosen by the farmer. Each topic in this workshop will be led by five nationally known leaders in this field. Each session will be briefly introduced with a presentation by each speaker, who will then lead a lively discussion of each topic among the workshop participants.

10:00–10:30 am

**Importance of Getting Nutrient Applications Right**

Robert Mikkelsen\*

International Plant Nutrition Inst, Merced, CA;  
rmikkelsen@ipni.net

10:30–11:00 am

**Selecting the Right Nutrient Source**

Mark Gaskell\*

Univ of Calif Coop Extn, Santa Maria, CA; mlgaskell@ucdavis.edu

11:00–11:30 am

**Getting Nutrient Timing Right**

Marc van Iersel\*

University of Georgia, Athens, GA; mvanier@uga.edu

11:30 am–12:00 pm

**Placing Nutrients in the Right Place**

David R. Bryla\*

USDA ARS, Corvallis, OR; brylad@onid.orst.edu

12:00–12:30 pm

**Getting the Rate of Nutrient Application Right**

Bielinski M. Santos\*

Gulf Coast Research and Education Center, IFAS,  
University of Florida, Wimauma, FL; bmsantos@ufl.edu**Wednesday, August 4, 2010****Springs A & B****Workshop 17:****Product Development through Private/Public Partnerships**

Sponsor: Industry Division

Coordinator: Peter Petracek, peter.petracek@valent.com

**Objective:** The goal of this workshop is to show the importance of private/public partnerships in product development and suggest ways to strength those ties. Presentations will illustrate previous examples on how private industry and public entities interacted to bring products to market. Examples from companies, universities and state and federal agencies will be presented.

10:00–10:30 am

**Industry Example: Commercialization of Abscisic Acid**

Johan Pienaar\*

Valent BioSciences Corporation, Libertyville, IL; johan.pienaar@valent.com

10:30–10:45 am

**IPNI Example**

Robert Mikkelsen\*

International Plant Nutrition Inst, Merced, CA;  
rmikkelsen@ipni.net

10:45–11:00 am

**FAO Example**

Daniel Gustafson\*

FAO Liaison Office for North America, Washington, DC;  
Daniel.Gustafson@fao.org

11:00–11:15 am

**University Example: Nutrphyte**

Carol J. Lovatt\*

Univ of California, Riverside, CA; carol.lovatt@ucr.edu

11:15–11:30 am

**Canadian Example**

Jerome Konecsni\*

National Research Council of Canada, Saskatoon, SK;  
jerome.Konecsni@nrc-cnrc.gc.ca

Wednesday, August 4, 2010

Desert Salon 4-6

Workshop 18:

## Screening Protocols to Assess and Predict Invasiveness in Plants

Sponsor: Invasive Plant Research (INPR) Working Group

Coordinator(s): Sandra B. Wilson, sbwilson@ufl.edu and Joseph P. Albano, joseph.albano@ars.usda.gov

**Objective:** (1) To discuss what plant characteristics and environmental factors are typical of plant invaders. (2) To discuss what predictive assessments or models have been developed, how they vary, and how effective they are at correctly identifying and rejecting potential invaders. (3) To use a specific plant example, run it through a typical status or predictive protocol (decision tree), and generate a risk assessment.

The substantial economic and ecological costs of invasive species management and removal warrant aggressive assessment and prevention programs. Numerous prediction protocols have been developed and tested to assess the potential of plants to become invasive with up to 96% accuracy. The Australian Risk Assessment is currently used to regulate plant introductions in Australia and New Zealand. This system may serve as an effective screening template on a broader, global scale to reduce the future importation of invasive plant species. This workshop will provide a platform for scientists to learn about the impact of invasive species, exchange information on the strengths and weaknesses of predictive tools in specific regions (including California and Florida) and bridge horticulture with ecology.

10:00–10:40 am

### Risk Assessment and Research Response of Florida-invasive Ornamentals and Their Cultivars

Gary Knox\*

North Florida Res & Ed Ctr University of Florida,  
Quincy, FL; gwknox@ufl.edu

Sandra B. Wilson

University of Florida, Fort Pierce, FL; sbwilson@ufl.edu

Numerous assessment tools have been developed with varying intent, scope and criteria in response to the significant negative economic and environmental impacts of invasive plants on natural areas and agriculture. Florida's favorable climate and abundant tourism, agriculture and population foster introduction and escape of non-native plants. The University of Florida/IFAS developed a process to evaluate and rank non-native plants for invasiveness in Florida's natural areas. Called the *IFAS Assessment of Non-Native Plants in Florida's Natural Areas* ("IFAS Assessment"), the purpose is to provide a well-defined, science-based mechanism by which all Florida Extension publications can consistently describe and categorize non-native plants, particularly those that are invading natural areas in Florida. The IFAS Assessment results in conclusions by species,

region within Florida (north, central and south), category and category-by-region. Conclusions are used to develop Extension recommendations intended to prevent further invasion of natural areas by non-native plants. All Florida Extension publications dealing with non-native plants must include references stating the IFAS Assessment recommendations. This common basis for decisions about invasive, non-native plants will increase consistency and improve understanding of recommendations made by University of Florida personnel. The IFAS Assessment is not used for regulatory purposes.

The IFAS Assessment consists of three parts: status assessment, predictive tool and infraspecific taxon protocol. All plants first go through the status assessment and may be subsequently directed to the other two components. The predictive tool is adapted from the Australian Weed Risk Assessment and is used for plants recently introduced (less than 10 years for herbaceous plants and 20 years for woody plants) or not yet in Florida.

The infraspecific taxon protocol is used for varieties, cultivars and subspecies that are expected to behave differently than the species. This component of the IFAS Assessment was developed in response to University of Florida research demonstrating apparent sterility or reduced invasiveness of some ornamental cultivars of otherwise invasive non-native plants. Species with cultivars showing reduced invasive tendencies were butterflybush (*Buddleja spp.*), lantana (*Lantana camara*), privet (*Ligustrum spp.*), chinese silvergrass (*Miscanthus sinensis*), heavenly bamboo (*Nandina domestica*), fountaingrass (*Pennisetum spp.*), mexican petunia (*Ruellia tweediana*) and porterweed (*Stachytarpheta spp.*).

Application of the IFAS Assessment will be demonstrated with *Nandina domestica* and *N. domestica* 'Firepower'.

10:40–11:20 am

### The Climate-matching Approach to Weed Risk Assessment

Lynn Sweet\*

University of California- Riverside, Riverside, CA;  
lwihb001@ucr.edu

Jodie Holt

University of California- Riverside, Riverside, CA; jodie.holt@ucr.edu

As invasive plants continue to increase worldwide, there is an increased demand to assess and categorize species for management priority. This study assessed the use of a climate-matching model to improve predictions of plant species spread. We analyzed species that had been chosen using expert opinion for designated listing as able to spread widely in California from a small distribution in 1999, and determined whether this model could have predicted more accurately the subsequent spread of these species. The model generally performed better than the expert opinion ranking. Although the model predictions showed varied success with trees and riparian species, good predictive outcomes were obtained for all herbaceous species. Climatic preferences and limitations should be considered for prioritiza-



tion of invasive species when planning large-scale management and early detection programs.

11:20 am–12:00 pm

### Weed Risk Assessment in California

Elizabeth Brusati\*

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California is a biodiversity hotspot for native plants and has become something of a hotspot for invasive plants as well, with >200 non-native, invasive plants causing impacts in California wildlands. More than half of the invasive plants in California were introduced as ornamental species. At the same time, horticultural plants are one of the largest agricultural crops in the state. Weed Risk Assessment can provide information on where invasive plants may spread and which new species may become the next invaders. Natural resource managers need to know where these plants may spread, especially as climate change progresses, in order to direct their early detection and control efforts. Meanwhile, it would be valuable for the horticultural industry to know which plants are or have the potential to become invasive so the industry can take proactive measures.

This presentation will describe several risk assessment projects by the nonprofit California Invasive Plant Council ([www.cal-ipc.org](http://www.cal-ipc.org)) and our collaborators. First, we are working to develop projections showing where invasive plants have the most potential to spread. One of the strongest determinants of a plant becoming invasive is its invasiveness in another region with a similar climate. We started with a group of 35 invasive plants and used Climex software to develop habitat suitability models that compare the global native and invasive range of each plant to the climate of California. We are now studying an additional 30 species, focusing on plants that are of concern in the Sierra Nevada, an area expected to be heavily impacted by climate change. We also surveyed lists of invasive plants in other mediterranean-type regions and compared them to the plants already naturalized (but not considered invasive) in California and to plants sold in the horticultural trade in California, in order to identify possible future invasive plants.

In California, the California Horticultural Invasives Prevention (Cal-HIP) partnership and its PlantRight campaign ([www.plantright.org](http://www.plantright.org)) are working to develop a Weed Risk Assessment based on the Pheloung model to screen new introductions. Since 2004, Cal-HIP has brought together environmental groups, horticultural industry groups, and government agencies to pursue

voluntary changes to reduce the sale of invasive horticultural plants. Cal-HIP works to remove invasive plants from the trade, identify research questions, and provide information to nursery owners, growers, and the gardening public.

Wednesday, August 4, 2010

Springs K & L

### Workshop 19:

## The Influence of Production Practices on Food Safety

Sponsor: Weed Control and Pest Management (WCPM) Working Group

Coordinator: Daniel C. Brainard, [brainar9@msu.edu](mailto:brainar9@msu.edu)

**Objective:** To examine the effect of cultural practices (insect and disease management and irrigation practices) on the movement of foodborne illness pathogens in horticultural crops.

Several foodborne illness outbreaks in recent years associated with fresh produce have led to the proposed legislation for more stringent food safety regulations for fruits and vegetables. This pending food safety legislation has the potential to alter fruit and vegetable production practices in the U.S. However, scientific research to support or refute the proposed regulations is greatly lacking. The purpose of this workshop is to examine the research currently being conducted on cultural practices as it pertains to the transmission of human enteric pathogens, such as *E. coli* O157:H7 and *Salmonella*. A case-study of tomato growers on the Eastern Shore of Virginia and their response to foodborne illness outbreaks will be presented. The workshop also will examine the role of flies as carriers of pathogens to food plants and the implications for IPM programs for insect management. Are some flies better vectors than others? What is a safe distance for an animal operation to be located from a fruit or vegetable operation to minimize the risk of contamination? The workshop will follow the life of the pathogen on the crop plant as well. How long will the pathogen persist? Can the pathogen move into the plant from the leaf or fruit surface? Lastly, the workshop will address potential remediation practices that growers can use to reduce the risk of pathogen contamination, such as treating irrigation water. Is drip irrigation sufficient to minimize foodborne illness risks? Is quarterly or yearly water testing meaningful in a crop production environment? This workshop aims to create a dialogue and fuel research among participants to develop cultural practices for fruits and vegetables that will reduce the risk of foodborne illness and shape the pending food safety legislation.

10:00–10:30 am

### Assessing the Role Good Agricultural Practices Play in Reducing Preharvest Contamination of Fresh Vegetables

Melanie Lewis Ivey\*

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Foodborne disease outbreaks caused by contaminated fresh vegetables continue to be a concern in the United States despite efforts by industry, academia and the government to reduce their incidence. Gaps, misconceptions and emerging perceptions among growers with regard to their decision-making process and practices concerning prevention of and response to pre- and post-harvest contamination were identified using responses to a mail questionnaire administered to Midwestern vegetable growers (n=621). Returned questionnaires (n=261) were coded and responses analyzed using non-parametric statistical tests. Only growers who self-reported as being *very* familiar with GAPs implemented them consistently (r=0.00). In contrast, there was no significant correlation between frequency of GAP implementation, such as water quality testing and equipment sanitation (r≤0.379), and GAP familiarity among growers who claimed any lesser degree of familiarity with GAPs (r=0.437). Growers strongly or somewhat agreed that pre-harvest plant diseases and pre- and post-harvest insects were sources of microbial contamination. Respondents were unsure if transplants and post-harvest plant diseases were a source of contamination (median response was “neither agree nor disagree”). Most growers strongly or somewhat disagreed that seeds were a source of contamination. Eminently, there is a gap in perceived knowledge between familiarity with GAPs and their actual implementation, except amongst the most knowledgeable growers. Grower’s beliefs that plant diseases can be sources of contamination warrant further studies in plant-human pathogen interactions on vegetables. These findings support the development of target-specific methods of communication and response.

10:30–11:00 am

### **Protecting Food Crops from Contamination with Filth Fly Transmitted Human Pathogens**

Alec Gerry\*

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Recent outbreaks of human illness due to *Salmonella* and *E. coli* associated with human food crops have received significant media attention and resulted in costly industry recalls. However, the

source of the contaminant bacteria in many of these outbreaks remains unclear. We are investigating the possibility that filth flies may be responsible for acquiring these pathogenic bacteria from domestic animals and moving them into human food crops. Some species of filth flies are commonly associated with animal feces and recent work by our group has shown that filth flies contaminated with *E. coli* O157:H7 can be found resting on human food crops such as lettuce. Furthermore, contaminated flies can deposit these pathogenic bacteria on visited plants. House flies exposed to *E. coli* O157:H7 were shown to regurgitate this bacterium onto spinach plants, with SEM revealing that bacteria adhered to the spinach phylloplane and increased in number after 7 days. The bacteria also adhered to the fly labellae and tarsi in low to moderately high numbers. Flies are known to disperse distances > 15 km, but probably commonly disperse less than 2-3 km from developmental sites associated with domestic animals. Placing food crop production facilities at distances over 2-3 km from domestic animal facilities will likely reduce the opportunity for contaminated flies to reach the food crop. Current research is evaluating the role of homopteran pests to attract filth flies to food crops as a result of honeydew production and deposition on the plant. Field collected flies offered a choice of attractant materials including aged honeydew colonized with sooty mold, commercial fly bait, and a milk-sugar-yeast liquid attractant, were significantly more attracted to the aged honeydew than to any other material tested. It is thought that flies and other insects are attracted to honeydew in the field as a source of sugars to support flight energy needs. Identification of the specific volatiles that are attractive to flies is one component of an ongoing research project funded by a nearly 1 million dollar research grant to lead PIAstri Wayadande at Oklahoma State University.

11:00–11:30 am

### **Tomato Food Safety Experiences and Improvements on the Eastern Shore of Virginia**

Steve Rideout\*

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11:30 am–12:00 pm

### **Irrigation Water Remediation for Vegetable Growers**

Christopher Gunter\*

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Fresh produce safety and human health are critical issues for farmers regardless of production scale. Consumers are demanding assurances from produce growers and retailers that their produce is safe. Through the use of Good Agricultural Practices, growers are able to identify important transfer points of pathogens to fresh produce. These include workers hands, animals and the water used on the farm. Irrigation water quality can be particularly difficult to manage if the producer is limited to surface water sources. One critical area of concern in production is irrigation water that is applied to the crop during the season. Knowing the quality of that water and methods to remediate that water if necessary are critical areas of concern. In an effort to address this potential source of contamination, growers are looking for practical and cost effective solutions to treat irrigation water prior to application. This talk will focus on methods of remediation currently available to fresh produce growers. The strengths and weaknesses of each system will be discussed. Research results with these systems will be highlighted where applicable.

**Wednesday, August 4, 2010****Desert Salon 1-3****Workshop 20:****Role of Roots and Rhizosphere in Organic/Sustainable Production**

Sponsor: Root Growth and Rhizosphere Dynamics (RHIZ) Working Group

Coordinator: David R. Bryla, brylad@onid.orst.edu

**Objective:** The objective of this workshop is to explore differences in the root environment and its function between conventional and organic farming systems.

Soil environments differ considerably between organic and conventional farming systems. In general, organic production systems have much higher inputs and retention of organic matter, which lead to larger labile pools of C, greater microbial activity, and increased availability of soil nutrients compared to systems that receive only mineral fertilizers. In this workshop, we will explore how such differences influence presence and function of roots and associations with microbial organisms in the rhizosphere. The speakers will discuss recent research on this topic and explore benefits and difficulties associated with soil management in organic horticultural production.

3:30–4:00 pm

**Blueberry Root Dynamics and Nutrient Management under Organic and Conventional Production**

Luis Valenzuela-Estrada\*

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Two principal differences that differentiate organic from conventional production in blueberry are nutrient management and weed control. Use of nutrient amendments, such as fish emulsion, feather meal, and yard debris compost, and weed control methods, such as surface sawdust mulch and black landscape fabric (weed mat), create rhizosphere conditions that differ from conventional systems. Organic soil amendments have a unique influence on soil chemical and biological properties, including soil pH, electrical conductivity (salinity), and the structure of microbial populations and fungal symbionts (ericoid mycorrhizae). Likewise, weed mat often increase soil temperature while sawdust reduces it, influencing various soil-temperature-dependent processes associated with microbial activity and root function (e.g., growth, respiration, nutrient uptake). Thus, to better predict crop growth and productivity in organic systems, proper understanding of the belowground processes is critical. However, while roots have been well studied in several major fruit crops, including apples, grapes and citrus, belowground research in blueberry is comparatively new and little is known about the timing of new root production, root lifespan, or root turnover in either organic or conventional systems. Preliminary results from two studies, an organic trial and a conventional trial, examining blueberry roots will be discussed in this presentation. Blueberry root dynamics were monitored using minirhizotrons and examined in relation to soil pH and soil electrical conductivity.

4:00–4:30 pm

**Rootstock Genotype Interactions with Rhizosphere Microbial Consortia, and Associated Responses to Apple Replant Disease**

Ian Merwin\*

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Janice Thies

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For 20 years we have investigated biological methods for managing apple replant disease (ARD), a common soilborne disease

complex with variable causes in New York orchards. Initially we evaluated different preplant cover crops and soil amendments in more than 30 orchards over many years. No preplant cover crops or soil amendments provided consistent ARD control across different sites and soil types, so we began searching for genetic sources of ARD resistance or tolerance in various *Malus* species and rootstocks. Testing some 1000 different accessions representing 19 species of *Malus*, we found several rootstocks (G.30 and CG.6210) from the Cornell-Geneva rootstock breeding program, and some *M. sieversii* seedlings that were resistant or tolerant to ARD in a composite mixture of soils from five NY orchards with known histories of severe ARD. When G.30 and CG6210 were later planted in an ARD orchard following preplant soil fumigation with Telone C-17, or soil compost amendments, 'Empire' apple trees on those two rootstocks grew and yielded substantially more than trees on M.7, M.26, or G.16 rootstock, and performed equally well in fumigated or non-fumigated locations, and in or out of the previous orchard tree rows. Molecular fingerprint studies (DGGE based on 16s rRNA) of root-zone soil samples from the different rootstock genotypes showed that G.30 and CG.6210 had different rhizosphere microbial communities than the Malling rootstocks. More recently we have investigated root-zone soil microbial consortia and severity of ARD on seven rootstock genotypes (M.9, M.26, G.30, G.41, G.65, G.935, and CG.6210) planted in soil where trees on four of those same rootstocks (M.9, M.26, G.30 and CG.6210) had grown for the previous 15 years. Rootstock genotyping showed that genetic distances among these rootstocks were correlated with their differential responses to ARD. Root-zone fungal and bacterial community composition (assessed with T-RFLP molecular analyses) differed between ARD resistant and susceptible rootstocks, and sequences matching with the *Burkholderia cepacia* complex (a putative disease-suppressive soil microbe) in the GENBANK database were obtained only from CG.6210 root-zone samples. Rootstock genotypes previously grown in the soil affected subsequent ARD severity differentially among these replant rootstocks, but replanting with the same rootstocks did not consistently exacerbate ARD severity. These results indicate that CG.6210 induces an ARD-suppressive microbial consortium in its rhizosphere, which may represent a novel mechanism for controlling this disease in orchards.

4:30–5:00 pm

### Rhizosphere Processes in Natural and Managed Systems: Implications of New Research for Soil Carbon Dynamics

Alex Gershenson\*

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Weixin Cheng

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The rhizosphere constitutes one of the most dynamic components of soil organic matter. Over the last decade we have gained many new insights into fine root dynamics, importance of root exudation, and rhizosphere microbial dynamics. California

seasonally dry systems in particular offer interesting research opportunities for examination of fine root dynamics and rhizosphere processes due to routine soil moisture limitations. New findings suggest a significant influence of rhizosphere processes on nutrient mobilization and soil organic matter decomposition. Understanding these mechanisms is critical for understanding overall soil carbon and nutrient dynamics, especially in the face of projected climate change, which will alter temperature and precipitation regimes.

5:00–5:30 pm

### Biochar Amendments Alter Soil Microbial Community Abundance, Activity, and Diversity: Is This a Good Thing for Organic Agriculture?

Janice E. Thies\*

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We have studied microbial community dynamics in terra preta soils of the Brazilian Amazon, rich in black carbon; and in temperate soils amended with corn stover biochar, planted to corn, in NY State. In the terra preta soils, bacteria and archaea responses were studied; whereas in NY, we focused on bacteria and fungi. Abundance was measured by plate and liquid culturing and by microbial biomass estimates. Activities examined include carbon respiration and soil hydrolytic exoenzyme activities. Diversity was investigated by SEM, T-RFLP DNA fingerprinting and cloning and sequencing of archaea, bacteria and fungi from the two regions. In general, soils high in black carbon and those amended with biochar harbor microbial communities that are more abundant, more active, release lower amounts of important greenhouse gases, and are highly divergent genetically from those in unamended soils. Other studies have shown that root growth and fungal hyphal extension are stimulated in the presence of biochar. Hold on though—before you go out and blanket your land with biochar—best to find out if biochar application is a desirable practice for enhancing the ecosystem services provided by the biotic component of soils under your care.

Wednesday, August 4, 2010

Springs H-J

### Workshop 21:

## Frontiers of Fruit

Sponsor: American Pomological Society (APS)

Coordinator(s): Chad E. Finn, cfinn@hort.oregonstate.edu; David A. Karp, dkarp@sprintmail.com

**Objective:** To discuss new, unusual and promising fruits grown in California and Arizona

In response to the increasing consolidation of retail chains and resulting pressure on wholesale prices, fruit farmers have sought either to become larger and more productive, or to focus on niche crops that command a premium. In California, particularly, competition to find new, lucrative fruits and cultivars is intense, as germplasm explorers, breeders and farmers have sought out novel or unfamiliar fruit types with distinctive appearances and

extraordinary flavors. For some, production aims at mainstream markets; other appeal chiefly to the diverse immigrant groups that abound in the state (tejocote). Some are traditional fruits, long neglected here but recently rediscovered (greengage plum); others are truly novel genotypes (peacotum; blood mandarin hybrid) originating from controlled crosses. Some are public, others proprietary. Some are profitably grown now; others are still under evaluation. Some require the warm, dry California climate, but others may be of interest elsewhere. All of the fruit types presented in this workshop are truly innovative and either have been commercialized or show potential for commercialization. Shifts in growing areas, following varietal demand and economic incentives, are also part of the picture (Arizona dates). The session will be followed by a tasting that will include samples of the fruits under discussion and other extraordinarily interesting or delicious cultivars.

3:30–3:35 pm

### **Introduction to the Workshop**

Chad E. Finn\*

USDA ARS HCRL, Corvallis, OR; finnc@hort.oregonstate.edu

3:35–3:55 pm

### **Date Cultivation in Arizona and the Bard Valley**

Glenn C. Wright\*

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The commercial date industry in the United States is located primarily in the Sonora Desert of southeast California and southern Arizona. Significant date plantations occurred in Arizona prior to those in California; the first importations of offshoots were made in 1890 from Algeria, Egypt and Saudi Arabia. By 1908, 135 varieties of dates were growing at a USDA station in Tempe, AZ. Date propagation techniques, date pasteurization, disease control and uniform ripening were some of the issues confronted at this early stage. From 1920 through 1950, the date industry developed; by 1946 there were about 150 ha in the state. Processing, packing, and marketing fruit became the major activity of the industry, which was centered in the Phoenix area, in the south-central part of the state. Some of this activity was enhanced by high fresh fruit prices due the lack of imported dates and high sugar prices during World War II. At this time, there was a vibrant research program conducted by the University of Arizona. Following the war, prices dropped, but new packinghouses were constructed and mail-order businesses were developed. However, the industry was struck by several freezes and late summer rainfall events in the 1950s, which severely damaged the crop. This, coupled with urbanization, and increased labor costs led to the demise of the Phoenix-area industry by 1960. From that time until 1990, there were virtually no dates planted in the state, but a Medjool industry was developing across the Colorado River from Arizona, in Bard, CA. Expansion plans by these growers led them to the inexpensive land and water in southwestern Arizona, and there has been a

resurgence of the industry. Today, about 1700 ha of bearing and non-bearing Medjools are planted in Arizona, and more are planned. There are also new packinghouses and a growing research program. The future of the Arizona industry is brighter than it has been in many years.

3:55–4:15 pm

### **Selection, Cultivation, and Commercialization of Central Asian Apricots in California**

John Driver\*

Driver Farms, Waterford, CA; jadriver@pmbx.net

Apricot production in the United States has declined over the past several decades, possibly due to the shift in consumer preference from canned to fresh fruit consumption, and consumer dissatisfaction with “supermarket apricots.” Consumers desire higher quality cultivars than currently available. Central Asia is a center of origin for apricot (*Prunus armeniaca* L). Recognizing this unique source of diversity, several breeding programs in the United States have incorporated Central Asian germplasm in their apricot breeding strategies. In the mid-1990’s, I collected a wide diversity of apricot seeds over a very extensive geographical range in Central Asia that formed the basis of our selection and breeding program. The diversity of this collection, which includes glabrous, white-fleshed, and dry-on-the-tree selections, will be presented. High soluble solids (21–30 °Brix) and complex flavors characterize our selections. Field trials of the most promising selections are underway worldwide, and commercialization has begun in California.

4:15–4:35 pm

### **New and Promising Citrus Cultivars in California**

Tracy L. Kahn\*

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During the past decade there have been significant changes in the number and types of citrus varieties grown in California for the commercial and specialty fresh fruit industries. This is due in part to the introduction of a number of new citrus varieties into California from other parts of the world and to recent releases of new varieties from the UCR Citrus Breeding Program. These include the introduction of proprietary varieties such as the anthocyanin-pigmented mandarin ‘Mandared’ or ‘Red Nules’, and the seedless lemon ‘Lemox’ or ‘Yellowstar’, as well as open introductions such as ‘Nordmann Seedless’ kumquat and ‘Cara Cara’ navel orange. This also includes new releases from the UCR Breeding Program such as the anthocyanin-pigmented pumelo hybrid ‘Valentine’, and a number of irradiated, low-seeded selections of traditional mandarin cultivars such as ‘Tango’, ‘Daisy SL’, ‘Fairchild LS’, and ‘Kinnow LS’. Characteristics of each of these varieties will be discussed. These new varieties are building market demand for seedless fruit, easy-to-peel mandarins with brightly colored and fine-textured rind, and citrus varieties with unique characteristics.

4:35–4:55 pm

### Evaluation of Central Asian Melon Varieties in the San Joaquin Valley

Richard H. Molinar\*

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Cantaloupes, honeydews, and watermelons were grown on 97% of the 27,200 acres of melons in Fresno County, CA in 2008. Only about 760 acres are devoted to “other melons” such as Casaba, Crenshaw, Galia, Juan Canary, Orange Flesh, Persian, Santa Claus, and Sharlyn. However the value of these melons is over \$3.5 million. The family of *Cucumis melo* includes many different subspecies of different shapes, colors, tastes, and sweetness. The Uzbek or Russian melon is one in this family that was grown on about 200 acres in 2001–04 under the trade name Silk Way. The farmers emigrated to the United States from Kazakhstan and began growing this specialty melon during this period. During the last 8 years melon trials were planted and evaluated at the Kearney Research and Extension Center in Parlier to evaluate the cultivars’ production, Brix, acceptability to the consumer, and other parameters. Varieties such as Hami, Piel de Sapo, Medellin, Fioli, Magenta, Esmerelda, Uzbek and others were planted and grown organically. During these trials the main disease problem was *Macrophomina phaseoli* (charcoal rot), a fungal soilborne disease.

4:55–5:25 pm

### Frontiers of Fruit in California: An Overview of New and Rediscovered Fruit Types with Potential for Commercial Cultivation

David A. Karp\*

University of California at Riverside, Los Angeles, CA; dkarp@sprintmail.com

Many California farmers and breeders are actively searching for new or rediscovered fruit types with promising characteristics such as exceptional flavor, unusual color or texture, novel interspecific parentage, perceived health properties, or value to ethnic communities. This session provides an overview of some of the most interesting species and cultivar groups currently being grown or under trial in California, including greengage and mirabelle plums (*Prunus domestica*); tejocotes (*Crataegus pubescens*); sweet-fleshed quinces (*Cydonia oblonga*); goji (*Lycium barbarum*); pollination variant, nonastringent persimmons (*Diospyros kaki*); red-fleshed peaches and nectarines (*P. persica*); and novel interspecific stone fruit hybrids such as Peacotums (*P. persica* × *P. armeniaca*). Coordinator: E. Barclay Poling, barclay\_poling@ncsu.edu *P. salicina*, Nectaplums (*P. persica* × *P. salicina*), and Cherums (*P. avium* × *P. salicina*). The treatment of each fruit type includes a description, and explanation of why it may be of commercial interest; its origin and history of cultivation, particularly in California; germplasm resources, including information on leading cultivars and their availability; environmental,

horticultural and postharvest requirements and challenges; and marketing and intellectual property issues. Many of the fruit types are potentially of interest for cultivation in states other than California.

Wednesday, August 4, 2010

Springs D &amp; E

### Workshop 22:

## Social Networking Tools and Delivery of Extension Programming

Sponsor: Extension Division and Commercial Horticulture (CHEX) Working Group

Coordinator: Richard E. Durham, rdurham@uky.edu

**Objective:** This workshop will explore the various social networking tools available such as Twitter, Facebook, Ning, blogs, and others, and describe how these tools might be used to assist in delivering Extension programming or better allow Extension staff or Extension staff and clients to interact.

Web 2.0, social networking, Facebook, Twitter, YouTube, blogs... The Internet is now much more than just a place to host content. Static Web pages have given way to dynamic portals where users constantly exchange and upgrade information. How do we in horticulture, and more specifically, we who deliver Extension information in horticulture, engage these new tools? Or do we engage them—is the learning curve too steep for adopting these resources compared to the professional and personal rewards for using them? How do we ensure our content remains objective and reliable? How do we set our content apart from other sources and receive credit for its development? What rules do we follow when engaging the public through social media? This workshop will highlight some of the social networking tools available and discuss how these tools may be useful in Extension programming and maintaining contact with colleagues and clientele.

3:30–3:50 pm

### Using Twitter and Facebook in Extension Programming

Steven Earl Newman\*

Colorado State Univ, Fort Collins, CO; steven.newman@colostate.edu

3:50–4:10 pm

### Using Ning to Connect with Colleagues and Deliver Content

W. Timothy Rhodus\*

Ohio State Univ, Columbus, OH; rhodus.1@osu.edu

4:10–4:30 pm

### Social Networking Tools and e-Extension

Terry Meisenbach\*

eXtension, Rancho Mirage, CA; tmeisenbach@extension.org

4:30–4:45 pm

## Summary of Best Practices When Using Social Media

Richard E. Durham\*

Univ of Kentucky, Lexington, KY; rdurham@uky.edu

Wednesday, August 4, 2010

Desert Salon 7

### Workshop 23:

## Strawberry Cold Protection and Crop Growth Enhancement with Floating Row Covers

Sponsor: Industry Division

Coordinator: E. Barclay Poling, barclay\_poling@ncsu.edu

**Objective:** Radiation frosts and freezes can seriously damage unprotected strawberry buds and blossoms. Historically, overhead sprinkler irrigation has been the primary strategy to protect this crop from cold injury, but in more recent years there has been a shift away from sprinkler irrigation to floating row covers in North Carolina's strawberry plasticulture production, as well as other strawberry growing areas in the Mid-South, Northeast and Midwest. Row covers have several important advantages over sprinkling, including important water savings, reduced soil erosion, reduced fertilizer leaching, and reduced fuel/energy usage. However, row cover application and removal is labor intensive and larger scale farmers in commercial growing areas such as Southwest Central Florida (>3645 ha), seriously question the technical and economic feasibility of utilizing row covers as an alternative to sprinkler irrigation for frost protection during their winter harvest season. There are added issues with row covers that relate to However, due to the severity of a freeze that occurred in Florida on January 11-14, 2010, strawberry producers were forced to pump more than 3.8 million liters/ha (407 thousand gallons of water per acre) to protect their crop from cold injury, and this led to massive sinkholes on Interstate-4 (Orlando–Tampa) as well as depleting neighborhood water supplies for over 400 residents in the Plant City area—where most of the industry's strawberry production is concentrated. Furthermore, sprinkler irrigation did not provide complete protection against crop cold injury on many farms in Jan. 2010. There is relatively little local expertise in using row covers as an alternative mitigation method in Florida, and an important purpose of this workshop will be to discuss how row cover technology might be profitably adapted to strawberry enterprises in Florida as well as other production areas in the US and North American where sprinkler irrigation has been the predominant method of frost and freeze protection in strawberry.

Radiation frosts and freezes can seriously damage unprotected strawberry buds and blossoms. Historically, overhead sprinkler irrigation has been the primary strategy to protect this crop from cold injury, but in more recent years there has been a shift away from sprinkler irrigation to floating row covers in North

Carolina's strawberry plasticulture production, as well as other strawberry growing areas in the Mid-South, Northeast, and Midwest. Row covers have several important advantages over sprinkling, including important water savings, reduced soil erosion, reduced fertilizer leaching, and reduced fuel/energy usage. However, row cover application and removal is labor intensive, and larger scale farmers in commercial growing areas such as Southwest Central Florida (>3645 ha), it is still very unclear as to whether covers are economically feasible as an alternative to sprinkler irrigation for frost and freeze protection. There is relatively little local expertise in using row covers as an alternative mitigation method in Florida, and an important purpose of this workshop will be to discuss how row cover technology might be profitably adapted to strawberry enterprises in areas in the US and North American where sprinkler irrigation has been the predominant method of frost and freeze protection in strawberry. Another purpose of this workshop will be to discuss the recent experiences of strawberry researchers in North Carolina for using floating row covers to advance the ripening season as well as to enhance branch crown development on the popular strawberry plasticulture cultivars Camarosa and Chandler. In addition, there will be information provided on various problems that have been encountered with row cover usage in the Mid-South such as mechanical injury to the plants and blooms under very high wind conditions and the reduced cold protection value of row covers that become wet and frozen.

3:30–3:50 pm

### A Grower Perspective on the Florida Strawberry Industry and the Impact of the January 2010 Freeze as well as How Row Covers May Be Utilized in Florida to More Effectively Control Frost and Freeze Losses

Porter Hare\*

Berry PatchesInc, Dover, FL; BerryPatchesInc@aol.com

3:50–4:20 pm

### Overview of Row Cover Applications in the North Carolina Strawberry Plasticulture System for Cold Protection, Crop Growth Enhancement and Forcing

E. Barclay Poling\*

NC State University, Raleigh, NC; barclay\_poling@ncsu.edu

4:20–4:40 pm

### A Two-year Study of the Influence of Row Covers in the Piedmont and Mountain Regions of North Carolina on Branch Crown Development, Marketable Yields, and Berry Size for the Cultivars Chandler and Camarosa

E. Barclay Poling

NC State University, Raleigh, NC; barclay\_poling@ncsu.edu

Jeremy Pattison\*

NC State University, Kannapolis, NC; barclay\_poling@ncsu.edu

Elizabeth Clevinger

NC State University, Kannapolis, NC; elizabeth\_clevinger@ncsu.edu

4:40–5:00 pm

### **The Practical Challenges of Using Row Covers for Large Commercial Strawberry Acreages**

Kris Nightengal\*

Intergro, Inc, Safety Harbor, FL; kris@intergro.com

5:00–5:20 pm

### **Industry Panel**

Wednesday, August 4, 2010

Springs A & B

### **Workshop 24:**

## **Teaching Sustainable Landscaping Practices in the College Classroom: Topics and Methods**

Sponsor: Teaching Methods (TCHG) Working Group

Coordinator(s): Marietta Loehrlein, mm-loehrlein@wiu.edu; Ann Marie VanDerZanden, vanderza@iastate.edu

**Objective:** The goals of this workshop are to enhance dialogue among college instructors on the emerging field of sustainable landscaping practices; to provide a networking opportunity to those already teaching a course on the subject, and to provide guidance and ideas to others; to examine current issues and trends for the future.

Sustainable landscaping is an emerging field within horticulture. Numerous sustainability-related practices are currently being implemented by landscape companies and others. Some of these practices are being widely and quickly adopted in the United States, Canada, and many other countries around the world. Regulations are being implemented by municipalities and other governing bodies seeking to address sustainability issues. Such issues include: stormwater run-off, consumption of non-renewable resources, contamination of water from fertilizers and pesticides, excess demand on limited potable water supplies, and carbon dioxide emissions.

The Green Industry is intricately involved in providing a number of solutions to address these environmental concerns. Some examples include: stormwater management using rain gardens, bioswales, vertical gardens, and vegetated roofs; use of recycled products in the landscape including rubber mulch and hardscape products using recycled glass; and composite wood products used in park benches, decking materials, and children's play equipment. Many of these landscaping practices have seen increased use in recent years. On a broader scale, urban design and planning that incorporates ecological design principles and

wildlife habitat creation and restoration are important aspects of sustainable landscaping. College-level horticulture and landscaping courses are responding to the need to prepare students for issues and practices in their respective professional areas. In this workshop, speakers will present curricula, class exercises, websites, and course materials they have developed and are using in each of their college-level courses. Faculty will discuss the use of online platforms for course material distribution.

Topics will cover the spectrum from ecological concepts to landscape design, construction and implementation, to maintenance and management. The Sustainable Sites Initiative and other emerging issues in sustainability will be discussed.

3:30–3:45 pm

### **Integration of Sustainability across a Landscaping Curriculum**

Eric Castle\*

University of Minnesota–Crookston, Crookston, MN; castl047@umn.edu

As long-term sustainability requires behavioral changes, concepts and techniques are woven through each course the curriculum. Specific coverage of emerging concepts, such as the Sustainable Sites Initiative, allows students to enter the workplace with cutting edge knowledge.

3:45–4:00 pm

### **Sustainable Landscaping: Issues and Practices**

Marietta Loehrlein\*

Western Illinois University, Macomb, Illinois; mm-loehrlein@wiu.edu

A new course was taught in Fall 2009 at Western Illinois University called Sustainable Landscape Practices. The course was designed to introduce students to the leading issues of concern in the landscape profession within the emerging field of sustainability. Such issues include water shortages, stormwater management, plant usage for energy savings, plants and native pollinators, habitat destruction, energy and landscape equipment, impact of pesticide use, and recycled/remanufactured materials. New technologies have been and continue to be implemented in response to these issues. Course materials included numerous pertinent websites, PowerPoint Presentations, hands-on activities, and design-oriented assignments. The semester presentation was a webpage design project, with each student contributing one topic page to the website. Course materials and student feedback will be discussed.

4:00–4:15 pm

### **Efficient Sustainability Instruction: A Discussion of ACCEPTs, a Multi-university Collaboration to Offer Online Courses in Horticulture and Sustainability**

Timothy Schauwecker\*

Mississippi State University, Mississippi State, MS; tjs2@msstate.edu



As a result of a partnership between Oklahoma State University, Louisiana State University, Mississippi State University, and the University of Arkansas, numerous horticulture courses are being offered to the member institutions in the online setting. One of the new course offerings is Sustainable Land Management, taught in the Department of Landscape Architecture at Mississippi State University. The course focuses on ecological principles and their application in the built environment. The course begins with a discussion of basic ecological concepts: scale, flow of energy and matter, productivity, disturbance, succession, and diversity. The impact that landscape managers have on each of these community properties is discussed. While the focus of the course is not intended to be on landscape design, retrofitting existing landscapes to be more responsive to ecological health is addressed at every opportunity.

4:15–4:30 pm

### **Sustainable Landscape Management Case Studies**

Ann Marie VanDerZanden\*

Iowa State University, Ames, IA; vanderza@iastate.edu

Sustainable landscape management addresses the interrelatedness of landscape design, construction and maintenance practices. This presentation will discuss the advantages and disadvantages of teaching with an online sustainable landscape management case study, and explore using case studies through a new online learning platform being developed at Iowa State University.

**Thursday, August 5, 2010**

**Desert Salon 1-3**

**Workshop 25:**

## **Control Mechanisms of Ripening and Senescence of Fruits and Vegetables, Part 1**

Sponsor: Postharvest (PH) Working Group

Coordinator: Jun Song, songj@agr.gc.ca

**Objective:** The objective of this workshop is to bring together leaders in the fields of postharvest physiology, plant breeding, genetics and molecular biology to address the recent research developments in the ripening and senescence of fruits and vegetables.

Consumption of fresh fruits and vegetables is increasing as consumers become more aware of their nutritional value and role in disease prevention. Improving quality of fresh produce reaching the consumer would add value, increase consumption, and create new markets for these commodities. Despite the development of many postharvest technologies and the optimization of storage conditions for many commodities, fundamental understanding of ripening and senescence of fruits and vegetables has not been fully achieved. Improved regulation of ripening and senescence is needed to optimize

market quality of these fresh products. Recently, there has been significant progress made by geneticists, molecular biologists and postharvest physiologists using state-of-the-art tools to reveal new insights into the ripening and senescence process. However, over the past 20 years, this topic has not been addressed as a workshop/colloquium at the ASHS annual meetings. The focus of this proposed workshop (parts 1 and 2) is to highlight recent developments in the area of ripening and senescence of fruits and vegetables. Better understanding and insight into ripening and its regulation could provide new approaches to optimize the preharvest environment, postharvest handling, and processing technologies, to control, maintain and optimize the quality of fresh fruits and vegetables. A summary of recent developments in the breeding and genetic regulation of fruit ripening will be provided by Dr. Susan Brown. Molecular biological approaches using mutants to determine regulation of fruit ripening will be discussed by Dr. Cornelius Barry. Genomic approaches for better understanding of the hormone interplay during fruit ripening and senescence will be summarized by Dr. Pietro Tonutti. The physiology of non-climacteric fruit and immature fruit will be summarized by Dr. Donald Huber. The classification of fruit and vegetables as climacteric and non-climacteric based on their biochemistry and physiology of ripening will be reviewed and debated by Drs. Randy Beaudry and Jeff Brecht. Finally, an implication and mechanism of 1-MCP on ethylene action and ripening of fruits and vegetables will be revealed by Dr. Chris Watkins. Discussion of those timely topics will help to clarify our current understanding of ripening and senescence and identify areas of need research.

8:00–8:30 am

### **Fruit Ripening and Senescence from a Fruit Breeder's Perspective**

Susan K. Brown\*

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Understanding postharvest disorders from a genetic perspective is complex and our efforts to identify markers effective in breeding is hampered by this complexity. Postharvest studies tend to concentrate on major cultivars of commercial importance and for the disorders that affect these prominent cultivars. Within a breeding program there are many more genetic backgrounds to be considered that influence expression of these disorders. Breeding programs often have progenies that might offer insights into the resistance/mechanisms of these disorders and processes of ripening and senescence. An overview will be provided on the use of such progenies, markers developed, and future prospects for collaborations among fruit breeders and post harvest physiologists.

8:30–9:00 am

### **Genetic Analysis of Fruit Ripening and Quality in Tomato**

Cornelius Barry\*

Michigan State University, East Lansing, MI; barycs@msu.edu

Fleshy fruits have a dual function in the reproductive strategies of plants. Initially, fleshy fruits protect developing seed from predation and then, once the seeds are mature, they facilitate dispersal to complete the plants reproductive cycle. Plants have evolved numerous chemical and physical barriers that discourage seed predation from fleshy fruits. Similarly, the ripening of fleshy fruits occurs through a range of coordinated biochemical processes that convert an unpalatable unripe fruit into a fruit that is nutritious and desirable to seed dispersing fauna. The biochemical changes that occur at the onset of ripening are species specific but several general processes occur that are common to many fruits, suggesting that the mechanisms that control ripening may be evolutionarily conserved. For example, fruit ripening is often accompanied by the accumulation of brightly colored pigments, the synthesis of aroma volatiles and the conversion of complex carbohydrates into sugars. These changes facilitate seed dispersal strategies. We have taken a forward genetics based approach to identify genes involved in determining fruit ripening and quality in tomato. Several genes have been cloned including *GREEN-RIPE* which alters ethylene responsiveness, *GREEN-FLESH* which is required for chlorophyll degradation and *LUTESCENT 2* which is required for normal plastid development and alters ripening time in tomato. Other loci that alter various aspects of fruit quality including cuticle composition and color development are currently being characterized and mapped with a view to identifying the underlying genes. Progress on these efforts will be presented.

9:00–9:30 am

### **Genomics Approaches for a Better Understanding of the Hormone Interplay during Ripening in Climacteric and Non-Climacteric Fruit**

Pietro Tonutti\*

Sant'Anna School of Advanced Studies, Pisa, Italy;  
pietro.tonutti@sssup.it

Genomics tools are increasingly used for elucidating and studying transcript profile changes and gene regulation at ripening and following different postharvest conditions, practices and treatments aimed at prolonging storage- and taste-life and/or affecting composition in both climacteric and non-climacteric fruit. Microarray hybridizations have been in particular useful to describe the role of ethylene by means of exogenous treatments with the hormone and the use of its antagonist 1-MCP. In peach fruit, analyses performed on both melting flesh varieties and ripening mutants such as Stony Hard allowed to identify possible hormonal cross-talk mechanisms involving ethylene and auxins. The expression of ethylene- and/or auxin-dependent genes involved in the metabolism and the action (Transcription Factors) of the two hormones is differentially modulated throughout peach fruit ripening suggesting the presence of regulatory inter-dependent mechanisms with auxins playing a crucial role. Although the burst of ethylene is not present at ripening in non-climacteric fruit, ethylene-related genes appear to be differentially expressed at the transition from immature to mature fruit as observed in olives, using a cDNA library subtractive hybridization approach, and in grapes where ethylene

treatments at veraison and in detached bunches deeply change transcript profiling (and the expression of genes involved in metabolism/action of other hormones) and affect berry ripening and composition. The presence of complex hormonal interplaying mechanisms governing grape berry development is confirmed by microarray analyses performed on berries treated with synthetic auxins at veraison extremely effective in delaying maturation and some specific ripening-related processes.

9:30–10:00 am

### **Deterioration of Commodities Harvested Immature: Specialized Forms of Programmed Cell Death**

Donald J. Huber\*

University of Florida/IFAS, Gainesville, FL; djhuber@ufl.edu

Postharvest development of fruits harvested at ripening-competent, physiologically mature stages of development typically ensues via orderly expression of ripening- and senescence-associated genes, resulting in changes in pigmentation, volatile production, and carbohydrate modifications that render the commodities suitable for human consumption. Storage regimes are often designed to delay but not permanently arrest these events. In contrast with ripening-competent fruits, other commodities including immature fruits, leafy crops and floral vegetables are harvested at stages of development in which mitotic activity and/or rapid physical growth are still underway. Once harvested, these commodities are incapable of continuing normal ontogeny and shelf life is maintained using storage conditions designed to strongly suppress global metabolism. The hypothesis under review is that immature commodities are genetically incapable of following a normal course of development upon harvest, and that their deterioration occurs via pathways unlike those exhibited by their fully mature, attached counterparts. Studies of accelerated aging in harvested immature commodities including asparagus spears (elongating, meristematic stem axes), broccoli (immature florets), young lettuce leaves, and immature cucumber fruit and pea carpels (immature, rapidly expanding fruit) have provided evidence that deterioration does not always parallel normal senescence but more so reflects highly specialized cases of programmed cell death (PCD). Triggered by multiple abiotic (environmental) and biotic (developmental) harvest stressors including ethylene, carbon depletion, and temperature extremes, the precise morphologies of cell death in these tissues are variable and dependent on organ type and stage of maturity at harvest. Commonly noted features of salvage-directed PCD include increased nuclease and protease activities, increased electrolyte leakage, vacuolar disruption and DNA laddering. Tonoplast rupture without DNA laddering was reported for harvested immature lettuce leaves, and distinct morphological and physiological senescence phenotypes were noted for different lettuce varieties. Differences among organ types are also noted in the timing of PCD events including DNA laddering, which can either precede or follow classic senescence symptoms (wilting, yellowing). In general, PCD events prior to visible organ deterioration occur in commodities harvested immature,

likely due to acutely perturbed homeostasis and remobilization metabolism. As a corollary, it is proposed that accelerated PCD/senescence in response to biotic and abiotic stressors in stored fruits and vegetables might constitute the underlying basis of some physiological disorders.

**Thursday, August 5, 2010**

**Springs D & E**

**Workshop 26:**

## Food Safety in the Tree Nut Industries

Sponsor: Temperate Tree Nuts (NUTS) Working Group

Coordinator: Richard Heerema, rjheerem@nmsu.edu

**Objective:** This workshop will introduce attendees to: 1) the food safety issues faced by the modern tree nut industries and 2) current research efforts to reduce food safety risks associated with tree nut products along the entire food production chain from the orchard to the consumer.

At a time when cropping acreage and markets of US tree nut industries are rapidly growing, widespread food safety issues have drawn increased attention. In particular, several highly-publicized national food recalls due to detection of dangerous microbial contamination have prompted increased concern among consumers, food producers and processors, and government regulatory agencies globally. The majority of these recalls have involved vegetable or meat products; nevertheless, a few major recent recalls have involved tree nut crops or peanuts contaminated by *Salmonella*. Even if no consumers are sickened by a contaminated food, the potential long-term negative economic impact of a high publicity food recall can be overwhelming for an industry as it works to regain consumer confidence in the safety of its product. In this workshop expert speakers from both academia and industry will explain the food safety issues faced by modern tree nut industries and describe research efforts underway to reduce risk of contamination of tree nut products in the orchard, as well as during harvest and processing.

8:00–8:30 am

### The Pistachio Story: An Industry Perspective

Bob Klein\*

Administrative Committee for Pistachios, Fresno, CA;  
bobk@acpistachios.org

8:30–9:00 am

### Orchard Management Impacts on Food Safety Risk in Almond

Bruce D. Lampinen\*

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Sam G. Metcalf

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Michelle D. Danyluk

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Linda J. Harris

University of California, Davis, CA; ljharris@ucdavis.edu

Three outbreaks of salmonellosis have been traced to raw almonds from California. Orchard management practices over the last 10 to 20 years have been increasingly moving toward higher-density plantings with resulting higher canopy light interception. These practices lead to orchard floor temperatures that are both cooler and more consistent. In a heavily shaded almond planting in California's San Joaquin Valley, where the majority of almonds are produced in California, orchard floor temperatures beneath the tree canopy are in a range where *Salmonella* is able to survive for longer periods. Since almonds are shaken to the orchard floor, left to dry for 7–10 days, and then picked up by sweeping, there is potential for substantial mixing of the nuts with the orchard floor surface. Additionally, almonds rewetted by irrigation water or rainfall release sugars that can support the multiplication of *Salmonella* either in the hull or when mixed with soil. Orchard management practices, such as maintaining sufficient light hitting the orchard floor, and reducing the potential for wet almonds to remain in the orchard may reduce the risk of *Salmonella* survival or proliferation in almond orchard soils.

9:00–9:30 am

### Aflatoxin Contamination in Pistachio and Almond

Themis J. Michailides\*

University of California, Parlier, CA; themis@uckac.edu

9:30–10:00 am

### Pathogens of Low Moisture Foods and Nuts: *Salmonella* Is the Pathogen of Concern

Linda J. Harris\*

University of California, Davis, Davis, CA; ljharris@ucdavis.edu

**Thursday, August 5, 2010**

**Springs A & B**

**Workshop 27:**

## Medicinal Plants of Asian Origin

Sponsor: Working Group of Asian Horticulture (WGAH)

Coordinator(s): Guangyao (Sam) Wang, samwang@ag.arizona.edu; Genhua Niu, gniu@ag.tamu.edu

**Objective:** The objective of this workshop is to discuss the current status of medicinal plants of Asian origin in the United States and Asian countries, and to identify opportunities and priorities for future research and development of these crops.

The broad ranges of geographic and climate across Asia have made it one of the most horticulturally dynamic regions in the world. Asia has a long history of agriculture and using medicinal plants, however, few medicinal species have been cultivated until recently. Because of the promising potential for developing new drugs from medicinal plants, there have been increased interests in the cultivation of medicinal plants as high value crops. In this workshop, experts from Asian countries and the U.S. will discuss the current status of medicinal plants of Asian origin and the opportunities and priorities for future research and development of these crops. The scope will include the domestication, medicinal use and/or nutritional value, genetic resources, and production practices. The limitations and challenges in the cultivation and use of these plants will also be discussed. In addition, this workshop will also identify collaborative opportunities for future development and commercialization of these crops in Asia and other parts of the world.

8:00–8:30 am

### **Medicinal Plants Used in Indian Traditional Medicine: Properties, Niche Market, Demand and Supply Initiatives in India**

Usha R. Palaniswamy\*

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G. Sivaraman

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India is a center of origin and/or a biodiversity hot spot for a number of medicinal plants. The traditional healthcare systems unique to India (Ayurveda, Siddha and Unani) use various combinations of many herbals. Over the past decade, the use of herbal products has increased among the mainstream in India, creating a greater demand for herbal products. This has generated a niche market for medicinal plants and several farmers are turning to cultivating them as a solo crop, integrating selected medicinal plants in their farming systems either as intercropped or incorporate them in crop rotations. The Siddha system of health care originated in the state of Tamil Nadu and predates the Ayurveda. This talk will focus on specific plant species used in the traditional Indian medicine, their medicinal properties and the current demand and supply initiatives in India.

8:30–9:00 am

### **Adaptability of Chinese Medicinals for American Growers**

Valtcho D. Jeliakov\*

Mississippi State University, Verona, MS; vj40@pss.msstate.edu

Jean Giblette

High Falls Garden, Philmont, NY; hfg@capital.net

Zoë Gardner

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Charles Cantrell

USDA-ARS, Natural Products Utilization Research Unit, University, MS; clcantr1@olemiss.edu

Lyle E. Craker

Univ of Massachusetts, Amherst, MA; craker@pssci.umass.edu

The increasing market demand for Chinese medicinals in the United States is currently being met by imports. Consistency of chemical profiles and available supplies of imported plant species as either dry or derived products is an occasional problem with Chinese herbs. Domestic production of Chinese herbs within the U.S. using good agricultural practices could most likely improve composition and biological activity of commercially available Chinese herbal products and provide new cash crops for US growers. Studies underway in Mississippi, New York, and Massachusetts to provide for economical and environmental sustainable production systems for Chinese medicinal herbs are being conducted. Field trials with *Scutellaria baicalensis* L., *Artemisia annua* L., *Forsythia suspensa* (Thunb.) Vahl, and *Salvia miltiorrhiza* Bunge are underway. Initial trials with *Scutellaria baicalensis* plantings produced good yields with a desirable range of baicalin and baicalein. All tested species appear adaptable to American fields located in the Southeast and Northeast and can be produced under organic growing conditions.

9:00–9:30 am

### **Opportunities for Cultivation of Traditional Chinese Medicine (TCM) Plants Outside of China: AMWAY's Experience with Nutraceutical and Beauty Products**

John Balles\*

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Yingqin Li

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AMWAY Corporation is a global leader in research & development, production, and marketing of nutrition and beauty products using medicinal plants sourced worldwide. Traditional Chinese medicine (TCM) is one of the primary resources for botanicals. AMWAY Corporation scientists have significant first-hand experience identifying and auditing farming enterprises in China that grow TCM plants to be used as raw material in the manufacture of products for worldwide distribution. This presentation will provide an overview of the current China regulatory situation, with regard to the botanical positive list and the allowed list for export for plant propagation. Commercial propagation of TCM plants within China follows different agriculture models and a prioritized list. Opportunities within and outside China for development of TCM plants for use in nutraceutical and beauty products will be discussed.

9:30–10:00 am

### Establishing a Collaborative Chinese Medicinal Herb Project

Jeanine M. Davis\*

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jeanine\_davis@ncsu.edu

Western North Carolina has a long history and reputation as a source of high quality, native medicinal herbs. For centuries, herbs such as ginseng (*Panax quinquefolius*) and black cohosh (*Actaea racemosa*) have been wild-harvested from the forests for sale around the world. The region is also home to many natural health practitioners and schools of herbalism. Over the past fifteen years, there has been a dramatic rise in the number of acupuncturists, Chinese medicinal herb practitioners, and traditional Chinese medicine (TCM) schools in the region. There is also a major TCM product distributor. Almost all of the herbs used in TCM in the U.S. are currently imported. Rising concerns over the quality and safety of these imported herbs, and the buy local movement, have fueled demand for domestically produced Chinese medicinal herbs. In response to this demand, a diverse group of people in the region representing two community colleges, county and state level extension, herb growers, herbalists, a Chinese medicinal herb school, a TCM distributor, and a renewable energy center, have come together to start a Chinese medicinal herb growing, marketing, and research project. For over fifteen years, Jean Giblette of High Falls Gardens in New York has been working with a small group of university faculty, TCM practitioners, and medicinal herb growers across the U.S. to establish a domestic supply of Chinese medicinal herbs. She met with our group, toured several of the farm sites and helped us develop a plan for our project. Upon her advice, we chose ten popular TCM herbs to grow on six farms and one research station. These include *Anemarrhena*, *Angelica*, *Astragalus*, *Chrysanthemum*, *Lycium*, *Paeonia*, *Pinella*, *Polygonum*, *Schizandra*, and *Scutellaria*. One of the community colleges is producing plants in tissue culture while some of the growers and my staff are producing transplants and cuttings. The other community college will do analytical testing of constituents in its natural products laboratory. The TCM distributor and the Chinese medicinal herb school will provide organoleptic testing. A variety of workshops for growers, herbalists, buyers, and consumers will be conducted. Several multi-state grant proposals on Chinese medicinal herbs are pending. If funded, these trials will be incorporated into those projects.

Thursday, August 5, 2010

Desert Salon 1-3

### Workshop 28:

## Control Mechanisms of Ripening and Senescence of Fruits and Vegetables, Part 2

Sponsor: Postharvest (PH) Working Group

Coordinator: Jun Song, songj@agr.gc.ca

**Objective:** The objective of this workshop is to bring together leaders in the fields of postharvest physiology, plant breeding, genetics and molecular biology to address the recent research developments in the ripening and senescence of fruits and vegetables.

10:00–10:30 am

### 1-MCP and Ripening of Fruit and Vegetables

Christopher B. Watkins\*

Cornell University, Ithaca, NY; cbw3@cornell.edu

The availability of 1-MCP has resulted in extensive research activity around the world on its effectiveness to improve storage potential and maintain quality of fruit and vegetables. At the same time, 1-MCP has also provided a valuable tool to understand the effects of ethylene on ripening and senescence. The effects of 1-MCP on the important factors associated with product quality - pigments, softening, flavor and aroma, nutrition, and on physiological and pathological disorders - will be reviewed. Understanding of the effects of 1-MCP on these factors is critical to the development of this breakthrough technology for many horticultural products will rely on the successful delay, but not complete inhibition, of ripening and senescence processes.

10:30–11:00 am

### Debating the Meaning and Utility of the ‘Climacteric’: Should Ethylene be the Essential Property?

Jeffrey K. Brecht\*

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Randolph Beaudry

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When the term ‘climacteric’ was first coined by Kidd and West in 1925, they referred to the increase in respiration that they had observed during the ripening of apple fruit. Kidd and West (1933) subsequently showed that ethylene stimulated the climacteric in apples, and Gane (1934) shortly thereafter provided conclusive evidence that ripening apples produce ethylene. Although numerous theories were put forth to explain the climacteric, the

usefulness of the concept as a frame upon which to hang the physiological and biochemical changes associated with fruit ripening was immediately recognized. It was assumed that climacteric respiration supplies the energy and carbon skeletons required for the various anabolic and catabolic processes associated with fruit ripening. Soon a veritable cottage industry arose among fascinated postharvest scientists who categorized virtually all commercially important (and unimportant) fruit species as climacteric or nonclimacteric according to either the presence or absence of a respiratory rise during ripening and whether or not ripening occurs in response to ethylene exposure. The response of climacteric respiration to temperature and atmosphere changes and the coordination of various physical and chemical changes with the climacteric have been thoroughly explored. For many years following the initial description of the climacteric respiratory pattern, ethylene was widely considered to be a by-product of ripening since the relatively insensitive techniques then available could not detect ethylene until after the onset of ripening. In the 1960s, that view began to wane as the use of gas chromatography showed clearly that very low levels of ethylene and increased tissue sensitivity to ethylene precede ripening. It is now universally acknowledged that the primary feature distinguishing climacteric plant organs is their capacity for autocatalytic ethylene production. Recent availability of 1-methylcyclopropane (1-MCP) to inhibit ethylene action has reinforced the concept of ethylene primacy. The question before us, then, is to continue using the term ‘climacteric’ as a respiratory descriptor or to shift its meaning to refer to the behavior of, and plant responses to, the hormone ethylene. As we debate this conceptual re-orientation, we should not lose sight of the fact that some three-quarters of the fruits and vegetables important in postharvest handling are not climacteric in nature; for most crops, control of global metabolism, for which respiratory activity is the most useful indicator, remains the postharvest scientist’s primary strategy for maintaining quality.

### Workshop 29:

Thursday, August 5, 2010

Desert Salon 1-3

## Partnerships in Education and Practice: Curriculum Development and Technology Transfer

Sponsor: Association of Horticulturists of Indian Origin (AHIO)

Coordinator: Usha Rani Palaniswamy, [usha.palaniswamy@gmail.com](mailto:usha.palaniswamy@gmail.com)

**Objective:** This workshop describes internationalization of US curriculum, research and outreach collaborative efforts in progress with Universities and research centers in India.

There is a national need for the US colleges to produce graduates who are globally competent which can be met by partnering with academic and research institutions outside the United States. The USDA supports “research, extension, and teaching activities that will enhance the capabilities of American colleges

and universities to conduct international collaborative research, extension and teaching” through the International Science and Education grants program. Among nations interested in educational collaborations with the US, India has taken steps to forge collaborations with the US through the US-India Knowledge Initiative on Agricultural Education, Teaching, Research, Service, and Commercial Linkages (AKI) that was announced in 2005. This workshop describes internationalization of curriculum, research and outreach collaborative efforts in progress with Universities and research centers in India.

1:00–1:35 pm

### Archived Reusable Learning Objects from the International Crop Research in the Semi-arid Tropics (ICRISAT) in Designing Online Teaching and Learning Activities

Usha Rani Palaniswamy\*

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V. Balaji

ICRISAT, Patancheru; [V.Balaji@cgiar.org](mailto:V.Balaji@cgiar.org)

The *Consultative Group on International Agricultural Research* (CGIAR) is engaged in research for development and plays an important role in mobilizing science to benefit the poor through its multiple centers and thematic programs. Additionally, the CGIAR centers are engaged in knowledge management and offer training for capacity building. The Learning Systems Unit of the International Crop Research in the Semi-Arid Tropics (ICRISAT, a unit of the CGIAR system located in Hyderabad, India) is engaged in innovative knowledge management in partnership with other world organizations such as the FAO and the World Bank. The virtual academy for the semi-arid tropics (VASAT) hosts learning modules on the production practices for its mandate crops (Pigeon pea, ground nut, chick pea, sorghum, pearl millet), as well as important topics such as organic farming that can be customized for the actual course and classroom needs. Topic maps on these mandate crops provide a comprehensive way of organizing and accessing knowledge on these crops. Additionally, the detailed descriptions of crop specific genetic and breeding procedures offer an in depth study suitable for courses in genetic engineering and biotechnology. Examples of the learning activities will be provided in specific online courses at Excelsior College, Albany, NY.

1:35–2:10 pm

### Promoting Resource Conservation Technologies in Northern India through Michigan State University’s South Asia Partnership Program

Daniel C. Brainard\*

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The College of Agriculture and Natural Resources (CANR) at Michigan State University (MSU) launched its South Asia Partnership (SAP) in 2009 to promote collaborative research, education and training, faculty and student exchanges, technology transfer, joint publications, and outreach activities with partners in South Asian countries including India. Key thematic areas include natural resource management and enhancing agricultural productivity and food security through new technologies. In the Indo-Gangetic Plain of Northern India, declining soil health, water scarcity, and shifts in labor markets present significant challenges to the sustainability of multiple cropping systems. To help address these issues, MSU is partnering with public and private institutions including The Energy Research Institute, Harayana University, and the International Rice Research Institute (IRRI). A recent SAP sponsored faculty visit to research sites in Harayana and Bihar Provinces revealed strong potential for fruitful collaborative research in the areas of 1) cropping system diversification, and 2) weed ecology and management in reduced tillage production systems.

2:10–2:45 pm

### **Foods for Health: Efforts to Expand Programs India to Increase Consumption of Indigenous Vegetable and Fruits**

Bhimanagouda S. Patil\*

Vegetable and Fruit Improvement Center, College Station, TX; b-patil@tamu.edu

In recent years, while consumer awareness of healthy foods seems to have increased, consumption of fruits and vegetables is still at slower rate both developing and developed countries. As a part of the Texas A&M University foot prints in India, the Vegetable and Fruit Improvement Center has initiated efforts to expand its multidisciplinary “Foods for Health” research and educational activities to India at the national and state level through partnership efforts. Opportunities and challenges to initiate bi-national efforts to improve human health will be discussed.

Thursday, August 5, 2010

Desert Salon 4-6

### **Workshop 30:**

## **Utility of Mechanistic and Empirical Models for Basic and Applied Research in Horticultural Stress Physiology: What You Need to Know Even If You’re Not a Modeler**

Sponsor: Environmental Stress Physiology (STRS) Working Group

Coordinator: Teri Howlett, [teri.howlett@colostate.edu](mailto:teri.howlett@colostate.edu)

**Objective:** 1) Provide attendees, whether experienced or not with modeling, with highlights, comparisons, and contrasts of

modeling approaches in basic and applied horticultural stress physiology research. 2) Provide panel discussion for audience and panel to discuss modeling uses, pros, and cons.

Do you know what your measurements are telling you? Horticultural researchers are utilizing models to relate small measurable variables to larger scale applications. For example, in environmental stress physiology, researchers can relate water use from the cell to the whole plant level. But how do you know if you need to utilize modeling or just take more measurements? What stepwise approach and variables are needed to go about using models for your research?

This workshop is intended for all of the horticultural science audience, whether unfamiliar or experienced with modeling. The workshop will provide attendees with highlights, comparisons, and contrasts of modeling approaches in basic and applied horticultural stress physiology research. Oral presentation will be followed by a panel discussion with questions from the audience and panel.

1:00–1:20 pm

### **Mechanistic Models: Application in Basic and Applied Woody Ornamental Water Relations Research**

Bill Bauerle\*

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Although the mechanistic approach to modeling transpiration has significant development and application costs, detailed mechanistic understanding and modeling of water flux components is needed to adequately predict water use in different woody ornamental production systems. In this synthesis, we discuss the current status of mechanistic models, methodological challenges, approaches to integrating models and measurements, and their applications in woody ornamental water relations. A combination of leaf and whole-tree measurements and stand-level extrapolations were used to assess how transpiration might be affected by the spatial and temporal resolution of a model. Statistical tools used to evaluate performance reveal potential limits of predictions and measurements while highlighting methods to increase the accuracy of model predictions.

1:20–1:40 pm

### **Sensing Green Roofs to Provide Continuous Data for Stormwater Modeling**

John D. Lea-Cox\*

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Andrew Ristvey

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Prior research has shown that green roofs can reduce stormwater runoff by 40-60%, but questions remain as to the relative contribution of the green roof substrate and plants at the

micro-scale, and the change in these relative contributions on a seasonal basis. Very few commercial / industrial green roofs are adequately monitored to provide continuous data, as green building (LEED) standards do not require performance metrics as a requirement for certification. We are developing low-cost sensor networks that utilize soil moisture and temperature sensors, in addition to aerial (light, relative humidity, air temperature, rainfall, wind speed and direction) sensors that can provide a continuous data stream for micro-scale monitoring. We will discuss these network capabilities and how we intend to integrate this information into existing green roof stormwater mitigation models.

1:40–2:00 pm

### **Converting Carbohydrates into Biomass: The Role of Respiration and Its Importance in Modeling Plant Carbon Use**

Marc van Iersel\*

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Almost all biomass production is dependent on carbohydrates fixed in photosynthesis. Because of the importance of photosynthesis for plant growth, photosynthesis and its responses to environmental stress have been studied in much detail. The efficiency with which these carbohydrates subsequently are converted into plant biomass is much less studied. This carbon use efficiency can be defined as the net amount of carbon incorporated into plants (gross photosynthesis minus respiration) divided by the total amount of carbohydrates produced (gross photosynthesis). Respiration at times has been seen as a wasteful process that reduces biomass production of plants. This view has resulted in unsuccessful efforts to select for faster growing genotypes by selecting for lower respiration rates. Approaching respiration as an inherently wasteful process neglects the fact that respiratory CO<sub>2</sub> losses are an essential and necessary part of plant metabolism. A more nuanced view of respiration can be developed by dividing respiration into two components, 1) respiration directly related to processes involved in plant growth (growth respiration) and 2) other respiration, generally considered to be the metabolism needed to maintain existing plant tissues (maintenance respiration). Carbon use efficiency is maximal when maintenance respiration accounts for a small component of the plant's carbon balance. In general, the importance of maintenance respiration increases as plant size increases, and carbon use efficiency drops as a result. Based on the efficiency of metabolic pathways in plants, the theoretical maximum for carbon use efficiency is about 0.70 (or 70%) when 'typical' plant tissues are produced. A better understanding of how growth and maintenance respiration respond to environmental stresses can help in understanding how plant growth is affected by those stresses

2:00–2:20 pm

### **Mechanistic and Empirical Models Simulating Nutrient Absorption and Response to Saline Irrigation Water in Floriculture Crops**

Neil Mattson\*

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Models in the plant sciences can be classified as being either mechanistic (also called "process-based") or empirical. In considering which approach to use one must be cognizant of the intended use (decision support, scientific knowledge) and intended plasticity of the model. Several complex factors interact to affect ion absorption by roots including root surface area, ion availability, organ sink strength, nutrient storage, remobilization, and nutrient antagonisms. A mechanistic model attempting to integrate these factors to simulate N, P, and K absorption demonstrated that remobilization of phloem mobile nutrients plays an important role in growth of flush-harvest cut flower roses. Empirical models are often used to describe a discrete plant response under fairly specific growth conditions. This approach was taken to describe growth response of several bedding plants in response to fertilizer concentration or saline irrigation water with the goal of aiding production management. In another case, an empirical model helped elucidate that one of the detrimental effects of high NaCl in irrigation water is that chloride acts antagonistically to inhibit nitrate absorption.

2:20–2:50 pm

### **Panel Discussion: Modeling Uses, Pros and Cons**

Bill Bauerle

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Teri Howlett\*

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Discussion between panel members and audience about modeling uses, pros and cons. Moderated by Teri Howlett.



Thursday, August 5, 2010

Springs D &amp; E

Workshop 31:

## Understanding and Manipulating Quality in Grapes and Berries

Sponsor: Viticulture and Small Fruits (VSF) Working Group

Coordinator: R. Paul Schreiner, paul.schreiner@ars.usda.gov

**Objective:** Discuss current goals and challenges to improve fruit quality in small fruit crops and identify production practices that promote their expression.

Small fruit crops are produced for yield and quality, where quality may be defined by fruit size, color, flavor, and human health-promoting compounds, among other attributes. The interactions among cultivar, production practices, and environment determine fruit quality. Thus breeding approaches and horticultural management should be considered integrally. In this workshop, we will explore traits that are important for quality of grapes and berries, how best to improve these traits through breeding and selection, and how environmental factors and production practices influence the expression of these attributes. The workshop will bring together breeders, horticulturists, and physiologists to foster discussion on the nature of genotype x environment interactions that govern quality in small fruit production.

1:00–1:30 pm

### Breeding for Quality in Grapes

James Luby\*

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Quality parameters that wine grape breeders must be concerned with include content of sugars, acids, anthocyanins and other phenolic compounds and a host of compounds that contribute to aroma and flavor of a wine. Some of these traits are far more tractable for breeding than others, though they are not necessarily easy to attain in all germplasm. Sugar and acid content are fairly easy to measure and target levels are well defined for breeders by winemakers' preferences or limitations of yeast strains. Anthocyanins and other phenolic compounds are somewhat more difficult to assay and their roles and interactions in determining wine quality are not as well understood. Defining breeding targets for these compounds is further complicated as their levels and form can change substantially with fermentation and aging of a wine. The most difficult challenge is to select for flavor and aroma. Wine flavor and aroma for a given genotype can vary depending on grape growing environment and wine production practices. Information on the type, number, levels and interactions of flavor compounds is still not well understood in grape by enologists and flavor chemists. Variation in human sensitivity to individual or interacting compounds further complicates breeding for flavor. The interaction of these multiple factors affecting flavor can result in significant higher

order interactions such as genotype x growing environment x winemaking practice x consumer preference/sensitivity that can greatly hamper evaluation and breeding progress.

1:30–2:00 pm

### Light and Temperature Effects on Phenolics in Dark-skinned Grapes

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During the past decade we refined our understanding of the effects of solar radiation and temperature on the accumulation of phenolic compounds in grapes in the field, particularly dark-skinned cultivars used for red wine. The work was precipitated by nearly universal prescriptive advice in the previous decade for growers to increase the exposure of the grapevine's fruiting zone to solar radiation, especially during ripening. However, in regions with hot summers and clear skies, growers and wine makers reported deleterious consequences of these practices on fruit quality. Our experimental approach included a field system to control dynamically the temperature of individual berry clusters on mature vines. In three separate studies we deployed up to 10 combinations of berry temperature and exposure to solar radiation, then assessed by HPLC methods the outcome on the classes of phenolic compounds that are most of interest to the grape and wine industry: flavonol-glycosides, anthocyanins, and proanthocyanidins in the berry skins. Concentrations of flavonol-glycosides increased with exposure to solar radiation, but these compounds were insensitive to field temperatures. High berry temperatures led to lower total concentrations of anthocyanins, except that malvidin-based anthocyanins, the predominant form, did not vary in concentration. Thus malvidin-based anthocyanins comprised a larger proportion of the total anthocyanin pool at higher berry temperature. A combination of low light and high berry temperature also decreased the total concentration of anthocyanins. At equal temperature, shaded and sunlit berries differed: exposure to solar radiation decreased the proportion of anthocyanins comprised of acylated derivatives and increased the proportion formed along one branch of the biosynthetic pathway (dihydroxylated anthocyanins). The consequence for wine quality from these compositional changes is not yet understood. Proanthocyanidins accumulate in the berry skin before the onset of ripening, with compositional changes occurring during ripening. Proanthocyanidins are otherwise known as "condensed tannins" and impart color stability and astringency to red wine. When the diurnal fluctuation in berry temperature was reduced ("damped") by cooling the berries during the day and heating them at night, the onset of ripening was accelerated. Higher berry temperature was positively associated with higher concentrations of skin proanthocyanidins at the onset of ripening.

2:00–2:30 pm

**Breeding for Quality in Blueberries**

James F. Hancock\*

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The overall fruit quality of highbush blueberry cultivars has undergone steady improvement since the crop was domesticated in the 1910s. In particular, advances have been made in fruit size, skin color, firmness and size of scar, as well as post-harvest storage life. Improvements in flavor have proven more difficult, with some of the more important cultivars being bland in flavor or too acid. Nutritional aspects such as antioxidant capacity, while deemed important, have received little direct breeding activity. A particularly large storehouse of genetic variability is available for improving fruit quality traits through wide species hybridization. It is not unusual for highbush blueberry breeders to release cultivars with three or more species in their pedigree. In particular, the incorporation of wild *V. darrowii* into the genome of the highbush blueberry has yielded numerous unexpected fruit quality advances. The future challenge will be to clearly identify those fruit quality characteristics of highest priority and produce improved genotypes that are still high enough yielding and in the appropriate cropping season to be economically feasible. It is likely that blueberry breeders will soon use genetic linkage maps and molecular markers to facilitate the selection process.

2:30–3:00 pm

**Irrigation Management Methods to Manipulate Fruit Quality in Blueberry**

David R. Bryla\*

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A trial was initiated in 2004 to compare the effects of sprinkler, microspray, and drip irrigation on water use and production in blueberry. One of the primary goals was to identify the best irrigation practices for optimizing both yield and fruit quality. Irrigation was examined in both an early-season cultivar, 'Duke', and a late-season cultivar, 'Elliott'. Plants were grown on mulched, raised beds and irrigated by overhead sprinklers, microsprays, or drip at 50, 100, and 150% of the crop evapotranspiration requirement ( $ET_c$ ). Overall, marketable yield and individual berry weight were higher in plants irrigated by drip than in those irrigated by sprinklers and microsprays. Yield and berry weight were also higher on average when plants were ir-

rigated at 100%  $ET_c$  than at 50%  $ET_c$  but were similar between plants irrigated at 100% and 150%  $ET_c$ . Thus, as expected, plants were generally under-irrigated at 50%  $ET_c$  and over-irrigated at 150%  $ET_c$ ; however, this was not always the case. Yield did not increase between 50% and 100%  $ET_c$  when plants were irrigated by drip, and berry weight increased from 100% to 150%  $ET_c$  when plants were irrigated by microsprays. Interestingly, drip reduced berry firmness and soluble solids relative to sprinkler and microspray irrigation, potentially increasing problems with soft fruit during shipping and storage. Titratable acidity was also lower with drip but only when plants were irrigated at 50%  $ET_c$ . While irrigation method and the amount of water application affected yield and fruit quality in blueberry, more work is needed to identify the best combinations of each to produce the most marketable fruit.

3:00–3:30 pm

**Breeding for Quality in Cranberries**

Nicholi Vorsa\*

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3:30–4:00 pm

**Nutrient, Water, and Canopy Management Effects on Quality in Cranberry**

Carolyn DeMoranville\*

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Quality in cranberry fruit is most commonly defined by fruit phenolics, sugars, acids and firmness (fresh market). In recent years, health research has focused attention on phenolic compounds and prompted research regarding how horticultural practices interact with the production of these secondary metabolites. Temperature and light appear both to play a role in phenolic development so horticultural practices that affect fruit temperature and/or light exposure of the fruit may be relevant. Canopy manipulation by pruning or sanding has been shown to affect fruit anthocyanins. Nitrogen nutrition can also play a role, most likely due to interaction with canopy architecture. The use of irrigation for canopy temperature management has been proposed as a method to affect phenolics in the fruit. The role of temperature and light in cranberry phenolic production will be reviewed and ways that this relationship might be exploited through cultural management will be explored.

**Monday, August 2, 2010 Springs A & B**  
**Oral Session 1: Crop Physiology:**  
**Vegetable Crops**

8:00–8:15 am

**Responses of Chip-processing New Variety ‘Goun’ by Fertilization Levels in Korea**

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A 3-year field study was conducted to investigate the physiological growth responses, tuber yield, and processing quality of newly released chip-processing variety ‘Goun’ as affected by fertilization levels. The nitrogen (N), phosphorus (P) and potassium (K) were calculated based on soil analysis and applied as urea, fused and super phosphate, and potassium chloride, respectively. Each fertilizer was applied at planting at levels of 0, 0.5, 1.0, 1.5, and 2.0 strength of calculated basal fertilization. Potatoes were harvested 70, 80, and 90 days after planting and evaluated tuber yield, specific gravity and chip processing. The results will be discussed.

8:15–8:30 am

**Effects of Agricultural Practices on Total Phenolics and Quality Attributes of Eight Selected Specialty Leafy Greens**

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Association between human health and bioactive compounds of leafy greens has been the focus of several academic and industry studies in recent years. Phenolic compounds, the largest group of plant phytochemicals, are of great importance both in plant physiology and human nutrition. Plants use these compounds as defense mechanisms against insects, pathogens, and photo-oxidation. The effects of phenolic compounds on human health have been investigated by various retrospective and prospective studies. Variation in agricultural practices may result in considerable change in nutritive value and quality attributes of leafy greens. This study investigated the effects of greenhouse, high tunnel, and open field cultivation methodologies on total phenolics, dry matter, total soluble solids, texture, and color profile of eight specialty leafy green vegetables (amaranth, huazontel, pac choi, tai sai, arugula, mizuna, komatsuna, and red iceberg lettuce) grown in Colorado. Huazontel, red iceberg, amaranth, Komatsuna and tai sai had significantly higher levels of total phenolics when grown in high tunnels or under open field conditions compared to greenhouse production. There was no difference in total phenolic content between plants grown under high tunnels and under open field conditions ( $P>0.05$ ). Similarly, huazontel, red iceberg lettuce, amaranth, komatsuna, arugula, and mizuna had lower total soluble solids and dry matter in greenhouse grown plants. No significant difference was observed among color and texture attributes in the majority of samples. This study indicated that although visual properties of the selected taxa were not detectable, the three production methods did produce significant changes in metabolites of leafy greens that may contribute to changes that impact nutritive value and quality attributes. Leafy greens planted in a high tunnel environment, in most cases, showed equivalent values when compared to open field samples, while greenhouse samples were lower in total phenolic compounds, total soluble solids, and dry matter relative to open field samples. Results of this study may contribute to a better understanding of plant responses to variation in agricultural methodologies, and may enhance the competitiveness of Colorado-grown vegetables, improving the profitability of local vegetable production.

*Specified Source(s) of Funding:* Colorado State Univ Agricultural Experiment Station, Project # COL00635

8:30–8:45 am

**Optimizing Foliar Application of Abscisic Acid to Improve Drought Tolerance of Melon Transplants**

Shinsuke Agehara\*

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Successful field establishment of vegetable transplants often depends on their ability to overcome post-planting drought stress. Abscisic acid (ABA) is known to act as a stress signal which triggers stomatal closure to reduce water loss. Greenhouse studies were conducted to determine the effects of ABA foliar application on growth and physiology in melon (*Cucumis melo* L., cv. Caravelle) transplants subjected to a short desiccation period. In the first study, plants were treated with seven concentrations of ABA (0, 62.5, 125, 250, 500, 1000, and 2000 mg·L<sup>-1</sup>) followed by 3-day desiccation. Net CO<sub>2</sub> assimilation rate (A<sub>CO<sub>2</sub></sub>) and stomatal conductance (g<sub>s</sub>) decreased exponentially with ABA 1-d after treatment, indicating that stomatal closure was rapidly regulated by exogenous ABA. However, this effect became gradually less noticeable thereafter. When A<sub>CO<sub>2</sub></sub> and g<sub>s</sub> were plotted against log-transformed ABA concentrations, their responses at the end of desiccation were best described by a quadratic function, with maximum A<sub>CO<sub>2</sub></sub> and g<sub>s</sub> occurring at 500 mg·L<sup>-1</sup>. This was probably because stomatal closure by drought stress exceeded that by exogenous ABA at 0–250 mg·L<sup>-1</sup>. In addition, ABA maintained higher leaf water potential and reduced electrolyte leakage, which was most significant at 500–2000 mg·L<sup>-1</sup>. Consequently, recovery of A<sub>CO<sub>2</sub></sub> and g<sub>s</sub> after rewatering was enhanced at those concentrations. Plants treated with ABA at 500 mg·L<sup>-1</sup> showed the greatest increases in shoot (38%) and root (45%) dry matter compared to untreated plants. In the second study, plants were treated with three concentrations of ABA (0, 125, and 500 mg·L<sup>-1</sup>) and grown with or without 5-day desiccation. Overall, A<sub>CO<sub>2</sub></sub> and g<sub>s</sub> responses to ABA were as observed in the first study. Plants exhibited a quick recovery from ABA within 3 d, regardless of desiccation. These results suggest that ABA foliar application at 500 mg·L<sup>-1</sup> is effective in improving drought tolerance of melon transplants by temporarily limiting transpirational water loss.

8:45–9:00 am

### Growth and Physiology of Artichoke Transplants Exposed to ABA, Heat, and Drought Stresses

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In southwest Texas, artichoke (*Cynara scolymus* L. cv. Green Globe Improved) seedlings planted in the field late summer or

early fall generally experience simultaneous high air temperatures and short drought episodes, causing transplant shock and delay in root and shoot development. A growth chamber study was conducted to determine the effects of heat (35/20 °C, day/night temperature regimes vs. 25/10 °C) and drought (daily maintenance at 30% water holding capacity vs. 60%) stresses on growth, physiology and water status of artichoke transplants during 14 days after transplanting (DAT). Heat stress significantly inhibited shoot but not root growth 14 DAT. In contrast, drought stress significantly inhibited root growth between 7 and 14 DAT. Plant physiological parameters including transpiration (E), stomatal conductance (g<sub>s</sub>) and photosynthetic rate (A<sub>CO<sub>2</sub></sub>) decreased by transplanting in all treatments (≤24h). Thereafter, E and A<sub>CO<sub>2</sub></sub> significantly increased by heat compared to 25/10°C temperature regimes 3 DAT. However as heat stress progressed there was a reduction in E, g<sub>s</sub>, A<sub>CO<sub>2</sub></sub> and leaf water potential. Drought stress sharply reduced E, g<sub>s</sub> and A<sub>CO<sub>2</sub></sub> within 1 DAT and leaf water potential and relative water content as early as 3 DAT. The combination of heat and drought stress significantly reduced shoot and root growth 3 DAT and all physiological parameters within 1 DAT, and plants did not recover throughout the 14 day-period. This suggests that to minimize transplant shock by heat and drought it is desirable to either condition seedlings to improve early root growth and/or to reduce leaf water loss by transpiration. A follow up greenhouse study evaluated the effects of three film-forming antitranspirants (Antistress, Transfilm and Vapor Gard) and abscisic acid (ABA, 500–2000 mg·L<sup>-1</sup>) foliar application on physiological responses and shoot water status of artichoke transplants exposed to drought stress (4-day water withholding). ABA at 1000 mg·L<sup>-1</sup> enhanced drought tolerance of transplants, a response that was associated with the maintenance of shoot water status via stomatal closure, whereas film-forming antitranspirants were not effective to mitigate drought stress. These results suggest that exogenous ABA could be a useful plant growth regulator to condition artichoke transplants to withstand temporal drought stress conditions and reduce transplant shock.

*Specified Source(s) of Funding:* USDA CSREES, RGBI and Designing Foods for Health, Valent BioSciences.

9:00–9:15 am

### Effect of Water Deficit and Nitrogen on the Different Stages of Plant Growth and Yield of Some Tomato Cultivars

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Two field experiments were conducted in two years, 2008 and 2009, at the Agricultural Research Station of King Abdulaziz Univ in Hada Al-Sham, northeast of Jeddah, Saudi Arabia, to test the effects of different concentration levels of nitrogen fertilizer (urea) and irrigation water intervals (water deficit stress) on plant growth of some tomato cultivars at different stages of plant growth and production. The results showed that water deficit regime caused reduction in plant growth (plant height,

stem diameter, number of branches/plant and number of leaves/plant). Water deficit also reduced number of clusters, flowers, and fruits/plant and reduced fruit mean weight and total yields of tomato cultivars. It also affected fruit length, diameter and sizes as well as wall thickness and number of lacules/fruit. Water deficit influenced vitamin C contents, acidity and total soluble solids in the fruit juice. The dry matter of vegetative and roots system was reduced due to the stress of water deficit. Nitrogen fertilizer increased the vegetative growth of tomato plants, such as plant height, diameter, number of leaves and number of branches/plant. Number of clusters, flowers, fruits/plant were also increased with increasing the concentration levels of nitrogen. Fruit mean weight and yield of tomato cultivars and fruit length, diameter and sizes increased with high level of nitrogen. Dry matter of vegetative and root system increased with nitrogen fertilizer. The responses of the tomato cultivars to water deficit stress and nitrogen concentration levels were greatly varied. Further investigations are needed using more (other) tomato cultivars to make better choice in selecting a cultivar, line, or hybrid for breeding program leading to the selection of a water deficit tolerable cultivar and to get the best efficiency of nitrogen utilization.

*Specified Source(s) of Funding:* King Abdulaziz Univ + King Abdulaziz Univ Jeddah – Saudi Arabia

9:15–9:30 am

### **Root Hydraulic Conductance of Tomato Is Reduced When Exposed to Abscisic Acid**

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Plants in retail settings routinely get inadequate water. As a result, their aesthetic value drops, which in turn reduces their salability. The phytohormone abscisic acid (ABA) is known to be naturally produced in response to drought stress, resulting in stomatal closure and reduced transpiration. Recent breakthroughs have made it more cost-effective to produce ABA, enabling researchers to examine its potential to function as a plant growth regulator. Previous work has shown that exogenous ABA applications can greatly reduce transpiration, and extend shelf life of unwatered plants. Paradoxically, we have seen that high rates of ABA may actually induce wilting. These wilting symptoms occur despite the presence of ample water in the substrate. This suggests that high ABA levels may interfere with the ability of plants to take up water from the substrate. Our objective was to quantify the effect of ABA on the hydraulic conductance of the root system of tomatoes. Tomatoes were grown in a glass greenhouse prior to the study for 8 weeks. The plants were cut off at the first node and connected to a vacuum pump, applying negative pressure to the xylem to simulate the effect of transpirational pull. Each pot received 50 mL of ABA solution with concentrations ranging from 0 to 1000 ppm. The amount of water pulled through the root system was recorded after 4 days, at which time the study was ended and the roots were examined. Results indicate

that as ABA concentration increased, root system conductance decreased. The volume of water conducted by the root systems during the 4-day period ranged from 14.34 mL in the control treatments to 3.98 mL in the 1000 ppm ABA treatment, a reduction of 72%. The roots were examined at the end of the experiment, and ABA did not impart any negative visual symptoms on the roots. We hypothesize that ABA affects aquaporins in the roots, limiting water uptake. Further work will need to be done to fully understand the way ABA affects the roots.

*Specified Source(s) of Funding:* Valent BioSciences Corp.

9:30–9:45 am

### **Effect of Hormonal Priming on Germination and Seedling Vigor of Tomato (*Lycopersicon esculentum* Mill.) cv. Nagina, Pakit**

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The present study was conducted to investigate the impact of the priming of seed with plant growth regulators commonly known as hormonal priming on the germination and seedling vigor of Tomato (*Lycopersicon esculentum* Mill.) cultivars Nagina and pakit. Tomato is herbaceous annual plant in which dormancy has been reported in freshly harvested seeds. Now a days, different methods are used to break the dormancy of seed including hormonal priming. Tomato seeds were primed with aerated solutions of salicylic acid (SA) and gibberelic acid ( $GA_3$ ) at the concentrations of 10, 50, and 100 ppm each for 24 h at  $25 \pm 2$  °C, respectively. All the priming treatments resulted in vigor enhancement as compared to the control (unprimed) and both of the cultivars behaved alike with minor differences. All of the parameters such as final germination percentage, germination index, mean germination time, vigor index, germination speed, T50, root and shoot length, total seedling length, fresh and dry weight of seedlings were found to be significant ( $P < 0.05$ ) for application of salicylic acid (SA) as priming agent. Priming with 10 ppm SA produced maximum FGP (88.50%) while minimum (59%) was observed in non-primed seeds. Similarly, MGT was also reduced when seeds were primed with SA and showed highly significant ( $P < 0.05$ ) results. Seed priming with 10 ppm salicylic acid proved to be the best in all the treatments.

*Specified Source(s) of Funding:* Higher Education Commission of Pakistan

**Monday, August 2, 2010 Desert Salon 1-3****Oral Session 2: Genetics/Germplasm/  
Plant Breeding: Fruit Crops**

8:00–8:15 am

**Three New Fig Cultivars for the Gulf Coast**

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'Champagne', 'O'Rourke', and 'Tiger' figs (*Ficus carica* L.) were developed by the Louisiana Agricultural Experiment Station. 'Champagne', 'O'Rourke', and 'Tiger' are the third, fourth, and fifth cultivars released, respectively, from a fig breeding program initiated in the 1950s to develop cultivars for the gulf south region. The three selections were evaluated at research stations in Louisiana. Three selections L55-13-22, L57-11-103, L57-13-121 were chosen for release because of superior fruiting characteristics. 'Champagne', 'O'Rourke', and 'Tiger', are selections from seedlings derived from a cross of 'Celeste' × 'C1' (a Capri fig from California). The crosses and selections were made by Dr. Ed O'Rourke. The fruit of 'Champagne' has a slightly round distal end and tapers slightly toward the stem end with a short neck. The fruit has a partially closed eye (ostiole) on mature fruit. Internal color is gold to caramel color when soft ripe. 'Champagne' fruit ripen about the same time as 'Celeste', the first week of July in Baton Rouge, LA. The main crop fruit of 'Champagne' ripens over a 15-day period which is comparable to 'Celeste' and 'Kadota'. 'O'Rourke' has a round distal end and tapers slightly toward the stem end with a long neck region. 'O'Rourke' produces fruit about 35 mm in diameter of moderate size (20 grams), light brown fruit larger than fruit (14 g) from the 'Celeste' cultivar. The eye of O'Rourke is not completely closed compared to a closed eye of 'Celeste'. Internal color is gold with some red near center of fruit when soft ripe. Fruit of 'O'Rourke' ripen 5 to 7 days before 'Celeste' or about the last week of June in the Baton Rouge, LA area. 'Tiger' fig produces good quality brown fruit with a darker brown stripe visible on most that are 30 to 40 mm in diameter, and weigh ~50 grams. The fruit of 'Tiger' have a partially closed eye on mature fruit. Internal color is yellow to gold with some red near center when full ripe. Fruit ripen about 5 to 7 days after 'Celeste' or about the first week of July in the Baton Rouge, LA area. The main crop fruit of 'Tiger' ripen over a 15-day period, which is comparable to 'Celeste'. Fruit of all currently recommended cultivars of figs will split and crack to some degree during the ripening stage when excessive moisture is present.

8:15–8:30 am

**Diversity of Low Chill Peaches from Asia,  
Brazil, Europe, and the USA**

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One hundred fifty-five peach (*Prunus persica*) cultivars, from Asia, Brazil, Europe, and the USA, were examined using eleven SSRs to study the genetic relationships among low chill as compared to high chill peach germplasm. Data was analyzed by NTSYSpc to form a similarity matrix using Nei and Li's Dice similarity coefficient. This similarity matrix was then subjected to a cluster analysis and a dendrogram was constructed using the UPGMA method. A wide range of diversity was detected, from 0.33 coefficient of similarity amongst the Thai peaches to 0.97 between two Brazilian peaches. The most distant clusters were the low chill peaches from Thailand and Taiwan and the local cultivars (both fruit and ornamental types) from China. Among the improved germplasm, there were distinct clusters for the Chinese/Japanese cultivars, three clusters for the Brazilian cultivars and one for the cultivars from the USA and Europe. The Brazilian materials clustered according to breeding programs in São Paulo and Pelotas reflecting the different sets of local cultivars used in the breeding efforts. The largest group investigated was the European/USA peaches. This group subdivided into three distinct clusters, with a general clustering of the low chill germplasm. The low chill accessions from Asia were genetically distant from the improved low chill peaches from the USA or Brazil. The low chill peaches from the Americas were more closely related to the high chill peaches developed in the USA and China/Japan due to the recent introgression of this germplasm into a low chill background.

*Specified Source(s) of Funding:* Texas A&M Univ, Department of Horticultural Sciences

8:30–8:45 am

**Rosbreed's Marker-assisted Breeding Pipeline**

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Translation of DNA information arising from genomics research into application in breeding is presently a bottleneck. RosBREED is a large-scale initiative seeking to bridge the chasm between genomics research and breeding programs, centered on breeders and ensuring they can capitalize on genomics discoveries and accelerating technological innovation. RosBREED's translational approach is the establishment and implementation of a marker-assisted breeding (MAB) "pipeline" consisting of a series of connected stages. At one end, any available marker-locus-trait (M-L-T) associations are objectively prioritized for each breeding program using socio-economically derived relative economic weights. In the next stages, markers are adjusted to match available genetic screening services. Then, each marker is assessed for relevance to breeding germplasm using the Pedigree-Based Analysis approach, determining the distribution of functional alleles in potential parents. Information is used to inform crossing decisions, improving proportions of genetically superior seedlings. Cost-efficient and logistically feasible marker-assisted seedling selection schemes are identified and trialed on several thousand seedlings to cull those predicted to have poor performance potential. Finally, robust genetic tests are routinely integrated into breeding operations, while newly reported M-L-T associations enter the pipeline. In 2010, in addition to the establishment of infrastructure components to powerfully enable each pipeline stage in future years, two major activities are taking place: 1) twelve demonstration breeders will each fast-track the pipelining of several already reported M-L-T associations, up to the stage involving marker-assisted parent selection decisions; 2) RosBREED will coordinate establishment of reference germplasm sets across programs representing U.S. breeding stock, begin standardized phenotyping for high-impact traits, and genotype these sets with genome-wide SNP markers targeting fruit quality candidate genes. The database of this comprehensive phenotypic and genotypic information on key germplasm will serve as the reference resource for future genetic discovery and validation and will exploit homology among genomes of three fruit-bearing genera of Rosaceae: *Malus* (apple), *Prunus* (peach and cherry), and *Fragaria* (strawberry). The archived database is expected to stock the shelf with hundreds of promising predictive M-L-T associations for entry into the MAB pipelines of many Rosaceae breeding programs. Successful demonstration of the RosBREED approach will lead to technology transfer to the wider community of U.S. Rosaceae breeders and international partners, so that, ultimately, new cultivars with superior fruit quality will be efficiently delivered by a powerful breeding network mobilizing modern technologies and exploiting the full extent of Rosaceae's genetic diversity.

8:45–9:00 am

### Use of PediMap in RosBREED for Visualizing Genetic and Phenotypic Data across Pedigrees in Rosaceous Crops

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RosBREED is a multistate, multi-institution project dedicated to genetic improvement of U.S. rosaceous crops and will be using applications of genomics knowledge and tools to accelerate and increase the efficiency of breeding programs. This project focuses on fruit quality traits in apple, peach, sweet cherry, tart cherry, and strawberry to demonstrate marker-assisted breeding. DNA markers that are genetically linked to fruit quality traits can play a critical role in identifying desirable parents for crossing. Breeders can efficiently make informed crossing decisions with DNA marker information when relevant data is displayed in a format that is easily visualized. PediMap is software designed to graphically present genetic information in pedigrees and can be used to present information such as phenotypic data,

observed marker alleles, identity by descent probabilities, and QTL functional allele probabilities, thus allowing breeders to visualize the distribution of desirable alleles for important breeding traits across their germplasm. The freely available PediMap software is currently being used by 12 RosBREED demonstration breeders. These breeders have collaborated to develop Crop Reference sets representing U.S.-wide breeding germplasm and Breeding Pedigree sets to further represent their own individual programs, and are already using PediMap to visualize pedigree relationships. Demonstration breeders have found PediMap to be a valuable tool even before the integration of DNA information. RosBREED outreach will extend the training and use of PediMap to the U.S. community of Rosaceae breeders, building on experiences and successes of the project's demonstration breeders.

9:00–9:15 am

### Germplasm Sets and Standardized Phenotyping Protocols for Fruit Quality Traits in RosBREED

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The prevalent Rosaceae crop breeding approach utilizes a common set of ancestors within breeding programs, resulting in relatedness among individuals and extensive linkage disequilibrium. Pedigree-Based Analysis (PBA) using FlexQTL™ software exploits these genetic considerations to identify and validate marker-locus-trait associations using genotype and phenotype information. RosBREED involves 12 demonstration breeding programs in five rosaceous fruit crops (apple, peach, strawberry, and tart and sweet cherry). Key roles for breeders in utilizing PBA to establish and exploit marker-trait associations are: 1) identifying founder germplasm sets for single nucleotide polymorphism (SNP) detection, and Crop Reference (CR) and Breeding Pedigree (BP) sets for genotyping and phenotyping, and 2) choosing important fruit quality traits and developing standardized phenotyping protocols to assess them. Breeders used PediMap software to visualize relationships and ancestry in their germplasm. SNP Detection Panels were assembled by including important founders that provide maximum likelihood of polymorphism detection based on pedigree position and presumed diversity. CR and BP sets were assembled to include important contemporary parents and offspring in breeding programs, as well as available ancestors. CR sets contain pedigree-linked germplasm that represents the diversity in current and anticipated future breeding stock. CR sets will be genotyped genome-wide with SNP markers and phenotyped for fruit quality traits and other high-impact traits. Breeders in each crop developed standardized phenotyping protocols for each trait, allowing data pooling across programs and more powerful PBA outcomes. Phenotyping protocols and PBA results for CR sets will be archived and made publicly available for reference at [www.rosbreed.org](http://www.rosbreed.org) (hosted on the Genome Database for Rosaceae). Breeders may add their own germplasm and phenotyping interests to the CR set data by collecting data and performing PBA on their proprietary BP sets combined with CR set data, to verify pedigrees and determine utility of marker-locus-trait associations for their own program.

9:15–9:30 am

## Using Socio-economic Values to Help Set Objective Plant Breeding Targets

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Plant breeders tend to subjectively establish their breeding targets based on a production orientation using interactions among their viewpoints, industry input, and market forces. This process could be improved by explicitly including the values and preferences of market chain participants like producers and processors, as well as consumers' purchasing motives, attitudes, beliefs, concerns, constraints, and willingness to pay. With use of such information, new cultivars would have targeted appeal to both large- and small-scale niche market segments, be more quickly accepted, and have enhanced commercial impact. To broaden the decision-making process, we will investigate the relative market value of several traits on the entire supply chain. This information must acknowledge and involve various key stakeholders at early breeding decision-making stages. RosBREED socio-economics activities will estimate social values and economic weights of fruit traits of five rosaceous crops (apple, peach, strawberry, tart cherry, and sweet cherry) as defined by key market chain members, including breeders, producers, market intermediaries, and consumers. We will gather information using multiple approaches, including one-on-one interviews and telephone surveys. We will develop and compare relative economic weights of various fruit quality and production traits on the five targeted RosBREED crops. Relative economic weights for a trait will be calculated as a weighted average of marginal values that the three key audiences (consumer, market intermediary and producer/processor) place on a trait, resulting in objectively quantified values for breeding priority setting.

9:30–9:45 am

### Diversity in Wild Apple Species of Chinese Origin

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The *Malus* collection in the USDA-ARS National Plant Germplasm System has twelve wild species of apple collected from China at the Plant Genetic Resources Unit (PGRU) in Geneva, NY. Between 8 and 148 individual trees represent each species. The assignment of seedling trees to specific species has been difficult due to the high levels of variation observed within species. We have collected phenotypic, ploidy, genotypic, and chloroplast sequence data for each of the field trees maintained at the PGRU that originated from seeds collected during plant explorations in China. Characteristic fruit and leaf characteristics specific to each species have been identified. Ploidy data have revealed that some species are diploid while other species have individuals with ploidy levels that range from diploid to hexaploid. Chloroplast sequence data have aided in species classification and phylogenetic analyses.

### Monday, August 2, 2010 Springs H & I Oral Session 3: Postharvest Physiology: Apple

8:30–8:45 am

#### Factors Affecting the Flavor of Fresh-cut Apples

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Supplying the increasing demand for flavorful, high quality fresh-cut fruits and vegetables is a continual challenge. The complex and dynamic nature of flavor production contributes to the challenge of satisfying consumer expectations. Understanding factors that impact the flavor of fresh-cut products could lead to improved technologies to optimize flavor. In this study the effects of cutting, packaging, and storage on the flavor of 'Gala' and 'Ambrosia' apple fruit (*Malus domestica* Barkh.) were determined. The process of cutting fruit increased rate of respiration and release of other volatiles. Respiration of slices was 3-fold greater than that of whole apples, while headspace concentrations of acetate esters and ethanol also increased. Packaging also impacts flavor. When 'Gala' apple slices were packaged in solid (S) or micro-perforated (MP) film bags and held at 5 °C for 14 days, slices held in the MP bags had higher fruit aroma, fruity flavor, perceived sweetness and better textural characteristics as perceived by a sensory panel than those packaged in S bags. Apple slices in the MP bags also had greater juiciness and higher concentrations of straight chain esters and estragole. The better flavor of the fruit in MP bag was associated with lower ethylene and higher O<sub>2</sub> concentrations in the package compared to the S bags. In an additional experiment in which CA stored 'Gala' and 'Ambrosia' apples were sliced, sealed in S bags, and stored for 14 days at 5 °C, total ester and estragole concentrations decreased 47% and 99%, respectively, during storage. All esters followed this trend with the exception of methyl butanoate and butyl acetate that increased 760% and 120% after 2 weeks of storage, respectively. Holding whole fruit for 14 or 28 days in air at 0 °C following CA storage had no effect on the total ester concentration of apple slices, but caused a decline in estragole concentration.

8:45–9:00 am

#### Gene Expression Related to Allergens in Apple Fruit During Ripening and Senescence

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Apple fruit (*Malus domestica* Barkh, 'Golden Delicious') is a well known nutritious fruit and its consumption is highly recommended for a healthy diet. Recent findings reported that apples consumption can cause allergic reactions to some people, especially northern and central European populations, because of the presence of allergens. Allergens are the unique proteins present in plants and many fruit that may cause an overreaction of human immune system. Investigations on apple fruit allergens include allergenicity testing, cultivar comparisons and cultural practices have been conducted by some research groups. Our own proteomic studies demonstrated the presence of many allergen isomers in apples that are also ripening dependent and under the influence of ethylene. In this study, apple fruit harvested at the pre-climacteric stage were allowed to naturally ripen or ripening was stimulated by treatment with 36  $\mu\text{L/L}$  ethylene for 24 h. Postharvest physiological indices including respiration, ethylene production and chlorophyll fluorescence were monitored at day 0, 7, 14 and 21. Real-time PCR was employed to investigate gene expression in relation to apple allergens at these stages. The study was repeated over two seasons. After efficiency tests for all designed primers, 16 genes from four major allergen isomers were selected to monitor gene expression. Through statistical analysis, including ANOVA and principal component analysis (PCA), 6 genes were found to change significantly during ripening. The Mal d1-1, Mal d1-4, Mal d1-associated protein (MdAP), Mal d4.01, Mal d4.02 and Mal d4.03 genes were significantly up-regulated in fruit during ripening and after ethylene treatment. A significant increase in expression of Mal 1.01, Mal d1d, Mal d1e and Mal d1g in ethylene treated fruit was also found, while the Mal 1.04, Mal d2.02 and Mal d2.03 genes decreased. In contrast, the Md1-3, Mal d2.01, Mal d3.01 and Mal d3.02 genes were not affected. Analysis and identification of gene expression during apple fruit ripening and senescence and in response to ethylene treatment demonstrated the complexity and dynamic changes of the transcriptional profiles of apple allergens. The characterizations of these allergens during fruit ripening and senescence are under further investigation through genomic and proteomic studies. Understanding the expression of these genes and their biological functions will aid in the control and regulation of the quality and safety of apple fruit.

9:00–9:15 am

### Phytosterol Conjugation in Cold-stored Apple Fruit Is Linked to Oxidative Stress and Ripening

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Low temperature stress is implicated in a wide-range of apple fruit postharvest necrotic disorders. Previously, untargeted metabolic profiling identified alterations in multiple metabolic processes that precede superficial scald symptom development. Metabolites with free sterol (FS) –like mass spectra were involved in this phenomenon. Subsequently, the identity of these compounds have been confirmed as glucose conjugates (SG), acylated glucose conjugates (ASG), and esters (SE) of campesterol and  $\beta$ -sitosterol. Different levels of each of these metabolites are linked to storage longevity, ethylene insensitivity, and oxidative stress demonstrating divergent control of phytosterol conjugation associated with these processes. Reduced SE and elevated ASG levels over 6 months of cold storage in air are associated with storage stress and scald symptom development.

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

9:15–9:30 am

### Characterizing Proteins for the First Committed Step in a New Biosynthetic Pathway for Ester Synthesis in Ripening Apple Fruit

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In ripening apple fruit, we propose a new pathway that uses the starting products pyruvate and acetyl-CoA for the synthesis of precursors to branched- and straight-chain esters. This pathway not only provides for the synthesis of isoleucine, but also for 3-, 4-, and 5-carbon fatty acids via the process of single-carbon fatty acid elongation. Our previous apple disc feeding studies, which documented the incorporation of  $^{13}\text{C}$ -labeled acetate into isoleucine and esters containing 2-methylbutanoate, a degradation product of isoleucine, supports this hypothesis. We identified two novel genes from apple, the sequence of which suggests that they are members of the 2-isopropylmalate synthase (*IPMS*) gene family. Purified His-tag protein from these genes was found to form citramalate and 2-ethylmalate from the  $\alpha$ -keto acids pyruvate and  $\alpha$ -ketobutyrate, respectively, when acetyl-CoA was added. Substrate specificity for  $\alpha$ -keto acids in decreasing order was  $\alpha$ -ketobutyrate, pyruvate,  $\alpha$ -ketovalerate, and  $\alpha$ -ketoisovalerate. *IPMS* differs from this protein in that it has a much lower preference for pyruvate. We therefore hypothesize the genes (*MdCIM1* and *MdCIM2*) are alleles coding for citramalate synthase, which contributes to carbon flux via a new pathway for ester biosynthesis. The hypothesized pathway constitutes a conceptual shift in the regulation of ester biosynthesis in that it implies synthetic, rather than catabolic pathways are responsible for ester precursor supply.

9:30–9:45 am

**Relating Apple Volatile Biology with Aroma Perception During Fruit Maturation**

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Aroma volatiles from fresh apple and other fruit result from autonomous biological activity and biological activity following cellular disruption, as during mastication. The lipoxygenase (LOX) pathway has been implicated in both autonomous and cell disruption-dependent processes. We investigated odor-active volatiles from 'Jonagold' fruit resulting from cellular disruption throughout maturation to better understand the relationship between volatile biology and perceived apple aroma. The study was conducted over 8 weeks and evaluations were twice-weekly. On each date, internal ethylene, CO<sub>2</sub> production, and volatile profiles were measured for whole fruit and crushed slices of 1-methylcyclopropene (1-MCP) treated ("non-ripening") and control ("normally ripening") apples. Only crushed slices were subjected to sensory analysis; sensory tests and volatile analyses of slices were performed approximately 2 minutes after crushing. Unexpectedly, panelists were able to distinguish between non-ripening and normally ripening fruit more than 2 weeks before the onset of the ethylene and respiratory climacterics in the normally ripening fruit. LOX-derived aldehydes *cis*-3-hexenal and hexanal were not detectable for whole fruit, consistent with dependence of LOX pathway activity on cellular disruption. For crushed slices, however, aldehyde synthesis was, at first, extremely high for non- and normally-ripening fruit such that the concentrations of *cis*-3-hexenal and hexanal were several hundred times higher than their respective odor thresholds. *Cis*-3 hexenal remained constant throughout the experiment for non-ripening fruit slices, but declined markedly for normally ripening fruit slices, coincident with autocatalytic ethylene formation. Conversely, hexanal emissions increased in normally ripening fruit slices at this time, but not in non-ripening fruit slices. The autonomously-produced ester butyl acetate increased coincident with panel detection of treatment differences, although the concentration of butyl acetate at this early stage of development was well below the human olfactory threshold. The data for autonomous and disruption-dependent aroma volatiles do not explain sensory analysis results.

9:45–10:00 am

**The Bounty of the Bite: Kinetics of Volatile Synthesis Following Cellular Disruption of Apple Fruit Tissue**

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During mastication and food preparation, cellular disruption of apple and other fresh fruit causes the mixing of cellular contents and induction of numerous chemical and enzymatic reactions not normally present in the intact tissue. Reactions associated with the lipoxygenase pathway result in the synthesis of significant quantities of volatile aldehydes, with the potential to contribute to alcohol, acid, and ester synthesis. These volatiles are known to impact aroma, herbivory, pathogen development, and insect predation. We wanted to determine if the kinetics of these reactions in apple changed with fruit ripening stage and if the changes in these parameters could impact the sensory quality of fresh fruit during consumption. Using a model system consisting of volatile collection chambers adhered to the surface of 'Jonagold' apple fruit, we found transient 'waves' of volatiles were produced. The initial wave was almost exclusively aldehyde products of the lipoxygenase pathway, which were then converted to alcohols, which, in turn, were incorporated into esters. The rate constants of these sequential reactions were estimated using mathematically-derived equations, providing a tool for comparing enzymatic capacities during ripening. The data indicate that lipoxygenase-derived aldehydes contribute to aroma of apple fruit during mastication, but alcohols and esters from these aldehydes do not. It is suggested that the impact of the lipoxygenase pathway on aroma is largely negative for apple during the eating experience

*Specified Source(s) of Funding:* Michigan Agricultural Experiment Station

**Monday, August 2, 2010 Desert Salon 4-6**  
**Oral Session 4: Herbs, Spices and Medicinal Plants**

9:00–9:15 am

**High Tunnel Grown Ginger-root as an Alternative Niche Crop for Southern Virginia Growers**

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Ginger rhizome is an aromatic, pungent spice which is used for cooking and has many health benefits. Ginger is one of the many spices that has crossed over to mainstream American consumers. In 2008, the U.S. imported 41,468.3 MT of ginger with a total value of 37.2 million dollars. Hawaii is the largest and the only commercial producer of ginger in the United States. Hawaii grew 18 million pounds of ginger in 2001, and due to ginger wilt caused by a bacterium known as *Ralstonia solanaceum*, the production has been severely reduced to only 1.8 million pounds in 2008. Ginger rhizome is traditionally grown under tropical conditions and it requires 9–10 months of growing time from planting to harvest. Therefore, it is not possible to grow ginger under field conditions in temperate zones. However, it is possible to grow ginger in a temperate zone under high tunnel conditions where it allows season extension. In 2008 and 2009, observational trials were conducted at the research facility of Virginia State Univ, and ginger seed rhizomes were planted in one gallon pots in a greenhouse facility in March. In mid-April, the plants were removed to a high tunnel and the plantlets were planted in the ground. A total of 25 plants were grown in the high tunnel for 11 months, and plants were harvested in mid-February of the following year. On the average, each plant produced seven pounds of marketable ginger. Growing ginger in a high tunnel is attractive because it provides an alternative niche crop for Virginia growers who sell directly to consumers.

*Specified Source(s) of Funding:* internal funding

9:15–9:30 am

**Capsaicinoid Concentration of Hawaii-grown Hot Peppers (*Capsicum* sp.)**

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Hot peppers have a long history in Hawaii and have potential as a high-value specialty crop for Hawaii growers. Capsaicin and related compounds are the primary determinants of pungency, an important attribute that influences end-use and consumer preference of the crop. However, virtually nothing has been reported on the pungent principles of Hawaii-grown peppers. To better understand the variability of these compounds among commercially available hot pepper germplasm, capsaicinoid concentrations were measured in 15 cultivars of three pepper species (*Capsicum annuum*, *C. frutescens* (tentative) and *C. chinense*) grown in replicated field trials at two locations (O'ahu and Molokai) July–October 2009. Market mature peppers were harvested, dried, ground and shipped to the Vegetable and Fruit Improvement Center, Texas A&M Univ. Total capsaicinoids were extracted in 100% methanol, then injected into an HPLC with a liquid phase of 45% acetonitrile, 0.5% phosphoric acid and distilled water. Capsaicinoids were separated on a NovaPak C-18 column. Variability in capsaicinoid concentrations across species was large, and ranged from 39  $\mu\text{g}\cdot\text{g}^{-1}$  to 21,395  $\mu\text{g}\cdot\text{g}^{-1}$  on a dry weight basis. The highest capsaicinoid concentrations were observed in a Habanero, 'Red Caribbean' (*C. chinense*). Fruits of cultivars 'Hawaiian' and 'Firecracker,' tentatively identified as *C. frutescens*, contained 13,077 and 9,197  $\mu\text{g}\cdot\text{g}^{-1}$  capsaicinoids, respectively. Although similar in appearance to *C. frutescens* fruits, small fruited peppers of *C. annuum* were lower in capsaicinoids, averaging 2,339  $\mu\text{g}\cdot\text{g}^{-1}$ . Exploiting the considerable genotypic variability among hot pepper genotypes for capsaicinoid concentrations is suggested as a strategy to improve marketing and value-addition of this crop.

*Specified Source(s) of Funding:* USDA HATCH, WSARE and TSTAR programs.

9:30–9:45 am

**Relationship Between Pepper Size, Harvest Time, and Labor Costs in Hawaii-grown Hot Peppers (*Capsicum* sp.)**

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Small fruited peppers of *Capsicum* spp. are heavily used in Asian-Pacific cuisine and are a common ingredient in local hot sauce, pickles and other value-added products in Hawai'i. Consequently, small fruited hot peppers have potential as a high-value

specialty crop for Hawai'i growers. Labor costs associated with hand-harvest are expected to be high and dependent on pepper size/weight. While the relationship between pepper size/weight and harvest time is unknown, we suspect that selecting cultivars within a market type for relatively large pepper size may reduce labor costs associated with hand harvest considerably. To test this hypothesis, 15 cultivars of three pepper species (*Capsicum annuum*, *C. frutescens* (tentative) and *C. chinense*) were grown in replicated field trials at two locations (O'ahu and Molokai) July–October 2009. Market mature peppers were harvested by experienced farm crews, and time to harvest each experimental unit was recorded. Harvest rates ranged from 0.9–4.5 kg per worker-hour for small-fruited cultivars including 'Hawaiian,' 'Firecracker,' 'Orange Thai,' 'Thai Hot,' 'Super Chili,' and 'Rooster Spur.' Harvest rates ranged from 13.6–40.9 kg per worker-hour for larger-fruited jalapeño and Habanero cultivars. Fruit size (volume) measured by water displacement exhibited strong linear correlation ( $R^2 = 0.98$ ,  $N = 105$ ) with pepper fruit weight across the range of pepper sizes. Average harvest rates for cultivars were strongly dependent on individual pepper weight. Within the small fruited types (0.7–4.5 g per fruit), it was estimated that harvest labor costs were reduced by 20% for every 1g increase in average fruit weight.

*Specified Source(s) of Funding:* USDA HATCH, WSARE and TSTAR programs.

9:45–10:00 am

### Potential Essential Oil Crops for Southeastern U.S.

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In 2006–2009, several field experiments were conducted in Mississippi to evaluate essential oil crops for commercial production in the region. These crops included peppermint (*Mentha X piperita* L.), Native spearmint (*Mentha spicata* L.), Scotch spearmint (*Mentha X gracilis* Sole.), Japanese cornmint (*Mentha canadensis* L.), sweet basil (*Ocimum basilicum* L.), holy basil (*Ocimum sanctum* L.), lemon grass (*Cymbopogon flexuosus* Nees ex. Steud.), lavender (*Lavandula vera* D.C.), summer savory (*Satureja hortensis* L.), winter savory (*Satureja montana* L.), oregano (*Origanum vulgare* L.), sweet marjoram (*Origanum majorana* L.), lemon balm (*Melissa officinalis* L.), wild bergamot (*Monarda fistulosa* L.), garden sage (*Salvia officinalis* L.), Clary sage (*Salvia sclarea* L.) and few others. Fertilizer studies were conducted on peppermint, Native and

Scotch spearmint, Japanese cornmint, sweet basil, and lemon grass, providing information on fertilization of these crops in the region. In addition, a number of varieties and accessions from peppermint, sweet basil, summer savory, oregano, and wild bergamot were evaluated for their adaptability to the environmental conditions of the region. Essential oil profiles of peppermint, Scotch and Native spearmints, Japanese cornmint, sweet basil, holy basil, lemon grass, lavender, savory, and wild bergamot have been analyzed for these crops grown under Mississippi climate and compared to the respective essential oils produced in other countries or regions. This oral presentation will summarize the major findings. Our 4-year field experiments and analytical studies indicated the above plant species have commercial potential as essential oil crops for Mississippi and possibly southeastern US.

*Specified Source(s) of Funding:* Medicinal Herbs Project Mississippi State Univ

### Monday, August 2, 2010 Springs K & L Oral Session 5: Teaching Methods

2:15–2:30 pm

#### Sustained Growth in Distance Education: What Were We Thinking?

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As distance education programs mature and increase in size, often the sponsoring institutions experience new and frequently conflicting metrics. The horticulture program in the Department of Plant and Soil Science at Texas Tech Univ currently has a twenty year high in enrollment while club membership is at a several year low. This spring, several courses had greater enrollment in online sections when compared to face to face sections. Increasingly, students are people who travel to their degree granting institution just to walk across the stage at graduation. What kind of impact does this environment have on a vibrant horticulture program and faculty members who are teaching at a distance? Perhaps we have a paradigm shift in what constitutes a collegiate experience. Several opportunities present themselves to help bridge the distance gap. Increased communication, intentional interaction with students, and faculty training to aid in remediating the impact of distance education on the on-campus experience are some considerations. In addition, course constructs, recruitment and retention practices, and long term planning are concerns which should be addressed.

2:30–2:45 pm

### **Perception of Mobile Information and Communication Technologies by a Herbaceous Ornamentals Class**

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Mobile information and communication technologies (ICTs) are useful for augmenting the teaching of horticulture related materials. A class of 26 students studying herbaceous ornamentals was asked to complete a survey regarding their use and interest in applications for mobile ICTs. Sixty-one percent of students in the course (31% of each sophomore, junior, and seniors in horticulture) completed the survey. Sixty-eight percent owned a mobile ICT (smartphone, PDA, etc.) and 73.3% of these had used at least one application on the device. Only 25% of owners had ever purchased an application for the device. All of the respondents thought a mobile application had the potential to assist them in learning herbaceous ornamentals and 50% also thought an application could be useful in their future careers. However, 43.8% did not want an application to replace the printed information already available for the course. When asked to rate the importance of possible features of an application the highest percentage of respondents said that identification characteristics (100%), colorful pictures (100%), common name (81%), scientific name (75%), and cultural information (75%) were very important. Other features like GPS location capability, maps of native range, and historical information were considered less important. Students also suggested that quick searching capability, thoughtful design, and an intuitive interface were also important.

2:45–3:00 pm

### **Integration of Service Learning throughout a Department's Curriculum**

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Higher education has enthusiastically adopted the concept and practice of campus-based civic engagement. Virginia Tech is a member of Campus Compact, a national coalition of more than 1,100 college and Univ presidents (representing over six million students), that is dedicated to promoting service, civic engagement, and service-learning in higher education (<http://www.compact.org/>). Within Virginia Tech, the Center for Student Engagement & Community Partnerships (CSECP) called for proposals for a \$10,000 award to a department or college that “best represents a coherent and innovative plan for developing infrastructure and enacting the curricular reform to realize engagement goals.” The Department of Horticulture won that award in 2009, and has developed a plan to integrate service learning activities in most of its courses. A key to winning this award was the incorporation of e-portfolios into the plan. All Horticulture students will be trained to use e-portfolios so that they will systematically record and track service-learning projects as well as academic work. The Department of Horticulture’s plan is to incorporate an integrated system for all Horticulture majors, from entry to graduation, to participate in highly experiential Service Learning projects. The goal is to enhance the community, value community-based-learning, to promote lifelong service and learning, and to reward collaboration both within and beyond the Department. Faculty will integrate Service Learning into most undergraduate courses (approximately 15; at least one designated as Service Learning) as well as Horticulture Garden and club activities. Hence, faculty culture will be transformed so that threads of Service Learning concepts are woven throughout the curriculum. A clear protocol will ensure projects are sound, effectively enacted, and evaluated upon completion. Following a detailed rubric, students will compose an e-portfolio synthesizing course projects and service learning activities at Virginia Tech. Portfolios will be presented in a capstone course; students will describe their projects, the progression of understanding, and improvements in knowledge and skills. Full implementation of the plan will be achieved by the spring semester of 2012. Successes and lessons learned from the first year of the plan’s implementation will be described.

3:00–3:15 pm

### **Teaching Research Methods via Strawberry Cultivar Evaluation in an Undergraduate Fruit Crops Course**

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Students taking Fruit Crops Laboratory (HORT 354) were given the opportunity to evaluate a total of 12 different strawberry cultivars and two timings of initiating plants for two cultivars. Sweet Charlie and Summer Festival were started as runner plants in early July or August and 50 plants of each were planted by the students with 50 each of the other 10 cultivars and placed in a cool (17 °C/22 °C) glass greenhouse on either 24 Sept. or 15 Oct. 2009. Plants were grown in 15-cm pots containing a soil-lite medium and were watered on an as-needed basis by the students. Observations were taken on color of foliage, timing

and quantity of flowers and fruit, frequency of runner formation and height of the plants. Because of time limits imposed by the semester ending, results were only assessed for early growth and harvest parameters. It was apparent that plant initiation in July was superior to August started plants, especially for Sweet Charlie. The students rated Albion, Darselect, Evie-2 and July started Sweet Charlie as the top performers. Additional student comments will be presented.

*Specified Source(s) of Funding:* UNL

## Monday, August 2, 2010 Springs D & E Oral Session 6: Crop Physiology: Environmental Stress

2:00–2:15 pm

### Effects of Drying and Extraction Conditions on the Biochemical and Biological Activity of Selected Herbs

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Herbs and spices have not only been used as food preservatives and flavoring, but have also been used as traditional medicines for thousands of years. Scientific evidence increasingly supports the potential health benefits of herbs with plant extracts displaying antioxidant, anti-inflammatory, antibacterial, analgesic, and antitumor activities. Chemical and biological activities of medicinal plants depend on many factors, such growth environment, harvesting time, and storage and drying condition. The objectives of this study were to evaluate the effects of extraction protocols and drying conditions on biochemical and biological activity of selected herbs. Four culinary and medicinal herbs: sage (*Salvia officinalis*), rosemary (*Rosmarinus officinalis*), peppermint (*Mentha piperita*), and common motherwort (*Leonurus cardiaca*) were dried at room temperature, 40 °C, or 70 °C. Extraction was conducted using 80% methanol or 80% ethanol. Total polyphenol was measured according to the Folin-Ciocalteu reagent method. Antioxidant capacity was determined with the Trolox-equivalent antioxidant capacity (TEAC) assay. The results showed both the drying conditions and extraction conditions could impact the total polyphenolic content and antioxidant capacity. In peppermint, 40 °C oven drying resulted in the highest antioxidant capacity level among all of the treatments when extraction was conducted using 80% methanol. When extraction was conducted using 80% ethanol, room temperature drying generated the highest antioxidant capacity level. The total polyphenol content and antioxidant capacity also varied with different herb species. The inhibitory effects of these herb extracts to cancer cell growth were also evaluated and will be discussed.

2:15–2:30 pm

### Commercial Extracts of *Ascophyllum Nodosum* Increase Growth and Improve Water Status of Potted Citrus Rootstocks under Deficit Irrigation

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Water availability is a pressing concern of modern agriculture on a global basis. Greenhouse trials have shown that vegetable, bedding and turf plants treated with commercial extracts of *Ascophyllum nodosum* have increased resistance to drought stress; however less work has been done on woody crops. Potted citrus rootstocks ‘Carrizo’ and ‘Swingle’ were grown for 4 weeks with or without seaweed extract (Stimplex, Acadian Seaplants Limited), then subjected to drought stress (50% evapotranspiration (ET), or remained under full irrigation (100% ET). Seaweed extract treatments were applied either foliar or as a soil drench, and continued through the drought stress period. After 4 weeks of seaweed extract treatment (prior to drought stress), extract treatment resulted in increased shoot length, which carried through the drought stress period. Both foliar and soil drench extract-treated plants had significantly increased shoot dry weight as well as leaf area and leaf dry weight. At the end of the experiment, no differences in root dry weight between treatments or stress levels were detected. Before drought stress was imposed, ‘Carrizo’ plants that had drench applications of seaweed extract had higher stomatal conductance than control plants, however ‘Swingle’ did not. Prior to drought stress there were no differences in stem water potential between treatments. After drought stress plants treated with an extract drench had less negative stem water potentials than did the foliar treated or the controls. Stem water potentials were similar between all treatments on plants that were not drought stressed. After 8 weeks of drought stress, photosynthesis was reduced similarly in all extract treatments. After 12 weeks of extract treatment (without drought), both drench and foliar treatments resulted in reduced stomatal conductance of ‘Carrizo,’ however ‘Swingle’ had increased stomatal conductance. Photosynthesis was reduced with drought, however after 12 weeks there were no differences based on extract treatment. After 12 weeks, ‘Carrizo’ showed no differences in water use efficiency (WUE) based on extract treatment or water stress, but ‘Swingle’ plants under drought stress with drench treatments of seaweed extract showed WUE similar to control plants without drought stress. Foliar treated plants under drought stress showed intermediate WUE compared to the drench and no extract treatments. These results show the potential for seaweed extracts to increase growth and improve stem water potential in citrus rootstocks under full irrigation and drought stress, as well as affect photosynthesis, stomatal conductance, and WUE, however these results appear to be cultivar specific.



2:30–2:45 pm

### Impacts of Soil Moisture Stress on Growth of Cultivars of *Miscanthus sinensis*, a Species Important to Bioenergy Crop Development

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Although it has been observed that *Miscanthus sinensis*, which is a widely cultivated ornamental crop and a candidate bioenergy feedstock, tolerates extreme water conditions in its native range in East Asia, not much is known about how extreme water conditions impact its growth and development. We postulated that while *M. sinensis* grown under well-watered conditions will exhibit high levels of growth, low levels of water availability will not negatively impact plant growth nor carbon-fixation rates. Potted replicates of two high-yielding ornamental cultivars *Miscanthus sinensis* ‘Silverfeather’ and *M. sinensis* ‘Malepartus’ were subjected under greenhouse conditions to three levels of soil moisture: flooded (45% volumetric water content (VWC)), well-watered (25% VWC), and drought (15% VWC). Soil moisture was maintained by an automatic irrigation system that monitored and maintained the prescribed moisture of each plant. Agronomic traits such as height, tiller number, and mass were recorded to compare treatment effects. Across treatments, plants in the high-moisture treatment developed more tillers than those in the medium and low-moisture treatments. Root-to-shoot ratio was highest in the high-moisture treatment. Interestingly, photosynthetic activity of both cultivars was lowest at the high-moisture level. Across treatments, ‘Malepartus’ appeared to be best suited to the range of soil moistures, generating more mass, height, and exhibiting higher net photosynthetic rates, but further research is needed to confirm these findings. This research may motivate those in the field of bioenergy production to consider selecting both *M. sinensis* cultivars for further development. If *M. sinensis* is able to sustain tolerance to extremes in water availability in the field, it is possible it could be produced where the highly productive *Miscanthus × giganteus* is unable to develop high yields under unirrigated conditions.

*Specified Source(s) of Funding:* Hatch

2:45–3:00 pm

### Slowly Developing Drought Stress Increases Photosynthetic Acclimation of *Catharanthus roseus*

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Plant drought stress studies often neglect the importance of the rate at which the drought stress is imposed. However, the rate of drought stress imposition may affect the physiological

responses of the plants to the drought. To test this, the change in the whole-plant photosynthetic rate of vinca (*Catharanthus roseus*) subjected to different drought imposition rates was monitored. A load cell-based, automated irrigation system controlled the rate at which the substrate dried out by changing the target pot weight gradually throughout the drying period. Fast, intermediate, and slow drying treatments reached their final pot weight [500 g, substrate water content ( $\theta$ )  $\approx 0.1 \text{ m}^3 \cdot \text{m}^{-3}$ ] after 4, 8, and 12 days, respectively. When  $\theta$  was  $0.15 \text{ m}^3 \cdot \text{m}^{-3}$ , whole-plant photosynthesis in the fast, intermediate, and slow drought treatments was reduced to 29, 60, and 75% of the pre-drought rate, respectively. Plants exposed to slow drying were able to maintain photosynthetic rates of  $> 50\%$  of the pre-drought rate at  $\theta$  of  $0.08 \text{ m}^3 \cdot \text{m}^{-3}$ . When pots weight reached 500 g, plants that dried slowly had approximately 0.4 MPa higher turgor than those subjected to fast drying, despite similar substrate moisture levels. Slow drying also resulted in higher whole-plant water use efficiency than fast drying. These results clearly show that the rate at which plants are subjected to drought stress affects the plants response to drought and this should be considered in drought stress physiology studies.

*Specified Source(s) of Funding:* Fred C. Gloeckner Foundation, USDA-NIFA-SCRI Award no. 2009-51181-05768

3:00–3:15 pm

### Modeling Canopy Carbon Gain and Water Use Efficiency in Response to Kaolin Residue Amounts in Fruit Trees

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Kaolin particle films are commonly used in horticultural crops to repel insects, and reduce heat stress and solar injury. Additional benefits of kaolin include improved canopy carbon assimilation, water use efficiency, crop yield, and produce quality. Recent studies as well as our previous research have shown that increased reflectance by kaolin particle films within the canopy are an important part of the underlying mechanisms accounting for the physiological enhancements at the canopy scale. Here, using a process-based modeling approach, we demonstrate that the enhancement in canopy carbon gain depends on kaolin residue amounts and that there is an optimal residue amount which maximizes canopy carbon gain and water use efficiency. We further illustrate that the optimal residue amount of kaolin varies with macro- and micro-climatic conditions, leaf photosynthetic and stomatal characteristics, and canopy architecture in fruit trees. We test these model predictions using the results from a 5 year field experimental study in which biomass and fruit yield were enhanced as a result of applying 12% kaolin particle films compared to 0 or 3% treatment in fully mature ‘Empire’ apple trees in Kearneysville, WV. These empirical data support the model predictions that the optimal residue amount may be relatively

high compared to what is commonly practiced in the field. We then apply the model to identify optimal kaolin residue amounts under various environmental conditions at different geographic locations using apple as an example.

*Specified Source(s) of Funding:* U.S. Department of Agriculture  
3:15–3:30 pm

### **Growth and Physiological Response of *Abies fraseri* to Drought Stress**

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Four-year-old seedlings of *Abies fraseri* [(Pursh) Poir] (Fraser fir) were grown in semi-controlled conditions in hoop-houses with five watering regimes (0.00, 0.62, 1.25, 2.50, and 3.70 cm/week), with the goal of determining the seasonal variation in the physiological response of this species to drought stress. Soil moisture and temperatures were continuously measured with sensors connected to a datalogger. Drought stress was monitored by measuring predawn ( $\Psi_{pd}$ ) and midday ( $\Psi_{md}$ ) levels in a subset of plants from each treatment. Physiological variables monitored were chlorophyll fluorescence ( $F_v/F_m$ ), Chl a, Chl b, total carotenes, and total carbohydrates concentrations. Several morphological characteristics including height growth, root collar diameter, and terminal shoot growth were measured. Predawn stem water potential values were generally higher (–0.8 to –1.9 Mpa) than midday values (–1.3 to –2.9 Mpa). Irrigation consistently increased both  $\Psi_{pd}$  and  $\Psi_{md}$  compared to the control treatments. However, the separation was less consistent in  $\Psi_{pd}$  and  $\Psi_{md}$  measurements between trees irrigated at 0.62, 1.25, 2.50, and 3.70 cm/week. This suggests a significant difference in stress between irrigated and control treatments, but low level of differentiation between irrigated treatments. Reducing drought stress resulted in increased plant relative height growth (RHG), relative root collar diameter (RRCD), and terminal shoot growth (TSG). Similar to stem water potential values, there was a clear contrast between control and irrigated treatments, and less variation between the various irrigation treatments. Photosynthetic pigments (Chl a, Chl b, and carotenes) decreased mid-season (14 July), and increased towards the end of the season (25 Aug.) in both predawn and midday measurements. There was a significant effect ( $P < 0.05$ ) of drought stress on photosynthetic pigment concentrations in both predawn and midday samples, with a very clear dose re-

sponse in the late season measurements (25 Aug.). These results were accompanied with a similar significant difference in  $F_v/F_m$  between control and irrigated trees. The seasonal variation in carbohydrate concentration was similar to photosynthetic pigments decreasing in the middle of the season and increasing late in the season. However, there was no clear contrast between irrigated and non-irrigated treatments. These results demonstrate that the drought response of *A. fraseri* seedlings include several physiological changes starting with the decrease in photosynthetic pigments caused by structural changes in the thylakoid membrane of the chloroplasts. However, the low differentiation in carbohydrate content suggests that there are parallel physiological and biochemical changes enhancing the capability of plants to survive and grow during drought periods.

3:30–3:45 pm

### ***Trichoderma*–Plant Association Enhances Plant Antioxidant Capacity and Tolerance to Abiotic Stresses**

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The soil fungus *Trichoderma*, and products based on effective strains thereof, is commonly used for disease biocontrol in horticulture and agriculture. Additionally, recent reports indicate that these fungi may also induce resistance to abiotic stresses. In order to better understand this phenomenon and use its potentials to improve crop production, we have studied its effects on germination and early seedling growth of tomato under various abiotic stresses. Treated seeds germinated consistently faster and more uniformly than untreated seeds whether the stress was osmotic, salt or suboptimal temperatures. The consistent response to varying stresses suggests a common mechanism through which the plant-fungal association enhances tolerance to a wide range of abiotic stresses. Redox state of the major non-enzymatic antioxidant molecules in T22-treated seedlings germinated in control conditions or under osmotic stress is enhanced in both roots and shoots of treated plants compared to untreated plants, especially under osmotic stress. Effects of plant-*Trichoderma* association on expression and activity of enzymes involved in recycling oxidized glutathione and ascorbate and other antioxidant enzymes and their importance in evolution of activated oxygen molecules and prevention of molecular and cellular damage will be discussed. The importance of these findings in better understanding of the molecular basis of this symbiotic relationship and its implication to improve seedling performance under stress has substantial commercial potential beyond current uses.

**Monday, August 2, 2010 Desert Salon 4-6**  
**Oral Session 7: Postharvest**  
**Physiology: Cross-Commodity 2**

2:00–2:15 pm

**Effect of Pre-storage Hot Water Treatment on Postharvest Sensory Characteristics of Non-melting Flesh Peaches**

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Heat treatment involves non-lethal stress that stimulates defense reactions in plants that protect them from subsequent stresses and is also known to inhibit ripening. Non-melting flesh (NMF) peaches were used in this study due to their reduced textural changes during ripening, which contributes to extended postharvest life and reduced postharvest mechanical injuries compared with traditional melting flesh (MF) peaches. The decreased capacity of NMF peaches to degrade cell walls (i.e., soften) could be related to a deletion of endo-polygalacturonase (endo-PG) gene or a truncation of the mRNA. The NMF peach cultivars 'UFSun' and 'Delta' were immersed in 46 °C (HT) or 20 °C (NT) water for 30 min before being placed at 20 °C for 5 days to allow ripening. The HT 'UFSun' fruit retained their initial flesh firmness throughout storage while this effect was observed only through Day 3 for 'Delta' fruit. Exo-PG activity was similar in both control and HT fruit, but endo-PG activity was significantly higher in HT fruit for both cultivars. Furthermore, the endo-PG activity of HT peaches was significantly higher in 'UFSun' than 'Delta', but exo-PG activity did not differ between the cultivars. The enhanced endo-PG activity in HT fruit of both cultivars did not parallel firmness changes since endo-PG activity was stimulated while the initial flesh firmness was retained. Soluble solids content, titratable acidity, and pH were also measured but there were no significant differences between the control and HT fruit for either cultivar. Hence, hot water treatment could be a potentially useful postharvest handling method to delay peach fruit softening without affecting their appealing flavor.

2:15–2:30 pm

**Storage Conditions Influence Plant Quality and Long-term Viability of *Ranunculus asiaticus* Dried Tuberos Roots**

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*Ranunculus asiaticus* is a desiccation tolerant flowering plant produced commercially by its dried tuberous roots. Low vigor and reduced "tuber" viability are common problems when these roots are stored for extended periods. We investigated "germination" and plant quality following storage under both short-term, and simulated long-term storage conditions and found an interaction between high temperature and humidity to be most detrimental. Tubers stored at 85% relative humidity were almost completely killed when held for 16 weeks at 25 °C, while those stored under the same conditions at 5 °C fared much better. Plant quality was shown to improve as storage humidity decreased.

*Specified Source(s) of Funding:* Fred C. Gloeckner and Post Schenkel Foundations. Also, California Flowerbulb Co.

2:30–2:45 pm

**Lysophosphatidylethanolamine, a Natural Phospholipid, May Retard Senescence and Improve the Shelf Life of Banana Fruit**

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Banana is one of the most consumed tropical fruits around the world. It is marketed nearly all year round and has very short shelf life. Fruits are harvested mature green and shipped in this stage to markets. Banana fruit ripens and senesces fast and become unfit for marketing within 1–2 days after turning yellow. Thus 1–2 days of improvement in the shelf life could add much market value. Previous studies conducted in our laboratory have demonstrated that Lysophosphatidylethanolamine (LPE) application can retard aging and improve shelf life of various fruits. No research has been conducted on banana with LPE. The objective of our study was to investigate the possibility of improving shelf life of banana fruit by a postharvest dip in LPE. For this purpose, whole fruits obtained from the market at ripeness stage of 2.5 (about 50% green) were dipped in a solution of 500ppm LPE (soy lecithin derived) for 30 minutes and observed for a period of four days at room temperature. Each treatment was applied to 50 fruits. From each hand an equal number of fruits were separated for LPE and control (H<sub>2</sub>O) treatments. At the end of four days when the control fruit started to show brown spots, the experiment was terminated. From each fruit peel slices were obtained for ion leakage measurement. LPE treatment had no significant effect on fruit weight loss. However, fruit diameter was reduced significantly more in control than in LPE treated fruits. Furthermore, ion leakage from the fruit peel was significantly higher in control than in LPE treated fruits. Visual observation showed that the LPE treatment improved the shelf life by about one day. Our studies strengthen the findings of earlier research that LPE can retard senescence by improving membrane health and suggest that a post harvest dip treatment with LPE could be used to improve shelf life of banana fruits.

2:45–3:00 pm

**Efficacy of Natural Compounds to Suppress Sprouting and Fusarium Dry Rot in Potatoes**

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Sprout and disease growth are ongoing concerns in stored potatoes. Reducing the rate and extent of both sprouting and disease can increase profit margins and allow the industry to produce a quality potato year round at a reasonable cost. Although there is a highly effective product, available in North America for sprout control in stored potatoes (CIPC – chlorpropham), there are concerns that this product; a) leaves residues which are a potential concern for consumers and b) is not suitable for use on seed potatoes or even in the vicinity of seed potatoes. This product is only available to licensed applications and is not suited for use by small scale or hobby growers. At present, there are no products registered for control of fungal diseases like *Fusarium dry rot* in stored potatoes. This project evaluated the potential to use the volatile compounds produced by a range of plants to control sprouting and disease development in stored potato. Potatoes (cv. Norland) were treated with the natural products in sealable 18L plastic containers. The products tested were; purified S(-)-carvone and R-(-)-carvone, dill weed, ground cloves, clove oil, garlic powder, diallyl disulfide extracted from onion, ground peppermint or peppermint oil. The liquid treatments were applied to filter paper disks attached to the lid of the plastic container, while the dried plant products were sprinkled over the potatoes. Each tuber was inoculated with *Fusarium sambucinum* (primary causal organism for dry rot in potato) just prior to treatment with the plant products. The potatoes were exposed to the treatments for 14 days at room temperature. After 14 days, the treatments were removed and the potatoes were held for another 14 days under the same conditions. Sprout suppression and incidence of *Fusarium dry rot* were evaluated 14 and 28 days after the treatment. A taste panel evaluated the impact of the various treatments on the flavor of the potatoes immediately after treatment and again after the 14 day holding period. Diallyl disulphide and carvone completely suppressed sprouting during the 14 day treatment period and slowed sprouting during the 14 day holding period. Garlic powder, peppermint oil and ground cloves also suppressed sprouting. None of the treatments provided any degree of control of *Fusarium dry rot*. Some of the treatments significantly altered the flavour of the potatoes. The altered flavor was considered desirable by some taste panelists and undesirable by others.

*Specified Source(s) of Funding:* Robert P.Knowles Scholarship

3:00–3:15 pm

**Development of Skin Burning Discoloration on Peach and Nectarine Fruit in Response to High pH Solutions during Postharvest Operations**

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A high level of a new skin damage incidence related to exposure to high pH during the brushing-waxing postharvest operations has been observed recently on some peaches and nectarine cultivars. As the causes that trigger this skin discoloration are different than those that cause traditional field inking previously reported, we have called this blemish as skin burning disorder. In this work, we have studied the combination of factors that could lead to skin burning discoloration in. Different susceptibility to skin burning was observed after screening 22 different peach and nectarine cultivars. A classification of the 22 studied cultivars depending on the rate of pH-related skin burning susceptibility has been suggested. Additionally, the role of phenolic compounds from the skin of peach and nectarine fruits in the skin burning development has been studied. The stability of the skin phenolic extracts to pH in the range 7–10 was studied with the aid of ultraviolet spectroscopy. This study demonstrates that fruit skin phenolic compounds are not stable to high pH, and that the transformations they suffer with high pH are time-dependent and non-reversible.

3:15–3:30 pm

**Hyperbaric Treatment and Fresh Tomato Fruit Respiration Rate and Respiratory Coefficient**

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A dynamic respirometer has been designed and built to measure the respiration rate (RR) and respiratory coefficient (RQ) of fresh

fruit and vegetable under pressure varying from 1 to 9 atm<sub>abs</sub>. This respirometer was tested on tomato for establishing the technical performance of the system. A method was developed to calculate the RR and RQ using the difference between the CO<sub>2</sub> and O<sub>2</sub> concentration at the air inlet and outlet or the respirometer. The solubilisation of some CO<sub>2</sub> within the internal liquid of the tomato fruit restrained our capability to determine the real RR and RQ during the transient period at the beginning of the hyperbaric treatment. This natural solubilisation process needs further study to elaborate proper method to measure the RR and RQ during the transient period. However, after reaching the gas equilibrium within the entire system, the respirometer allowed the determination of the pressure range that generates significant effects on the RR and RQ of tomato without generating physical or physiological damage. A replicable effect on the RR and RQ of pressurized tomato was identified. Tomato fruit subjected to 3, 5, and 7 atm<sub>abs</sub> treatments had a RR reduction of 11%, 16% and 20% compared to untreated fruit, respectively. Submitting tomato fruit to 9 atm<sub>abs</sub> generated irreversible damage and caused anaerobic respiration. These results were in line with the results presented in the literature showing a reduction of CO<sub>2</sub> and C<sub>2</sub>H<sub>4</sub> production when pre-climacteric fruits were stored at 5 atm<sub>abs</sub>.

3:30–3:45 pm

### Preharvest Factors Affecting Postharvest Peel Breakdown of Fresh Citrus

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Florida is the largest producer of citrus in the U.S.A., especially oranges for the juice market and grapefruit for the fresh market. Peel breakdown of fresh fruit usually manifests itself after packing and shipping and can result in major economic losses. Unusually severe peel breakdown problems were reported during the 2006–07 and 2007–08 fresh citrus seasons. Plots were established from 2007 to 2010 in commercial groves using standard fresh fruit growing practices to evaluate the effects of foliar nutritional sprays and water stress on peel breakdown of fresh citrus. Mono-potassium phosphate (MKP) was applied at 10.65 Kg MKP per acre (0–52–34; 3.62 Kg K<sub>2</sub>O per acre) with 1.81 Kg per acre low-biuret urea (46–0–0), magnesium (Mg) was applied at 6% (4.53 Kg Epsom salts / 75.70 gal), MKP + Mg was applied separately as two tank mixtures, or an antitranspirant (Vapor Gard®) was applied at concentrations of 1% and 2% as whole tree foliar sprays at a rate of 473.17 L per acre. In addition, whole-tree water stress was induced by withholding water for up to 2 months before harvest. Fruit samples were harvested at weekly or biweekly intervals and held at ~22.7 °C and 50% to 60% RH for 3 days before washing, waxing (carnauba) and then storing the fruit under ambient conditions. Evaluation of decay and the development of peel disorders and other physiological

disorders occurred weekly or bi-weekly. Tree water stress was measured using a pressure bomb. Incidence of peel breakdown significantly increased after blocking irrigation and rainfall for 49 days before harvest. Foliar application of K, Mg, K + Mg, and Vapor Gard® reduced peel breakdown by about an average of 35.63%, 35.22%, 29.94%, and 45.03% respectively compared to control fruit. This trend continued the following season with less peel breakdown from the Vapor Gard® treatment whereas results from foliar K and Mg were not always significant.

*Specified Source(s) of Funding:* Travel Grant

3:45–4:00 pm

### Microbiological and Organoleptic Quality of Fresh-cut Vegetables Treated with Disinfectants and Stored in High CO<sub>2</sub> Atmospheres

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Microbiological and organoleptic quality of fresh-cut lettuce, spinach, carrots, and Japanese radish was evaluated after treatments with disinfectants and stored in high CO<sub>2</sub> atmospheres (10%, 15%, and 20%) at 10 °C. The samples were initially treated with a 1% fumaric acid agent (0.2% of fumaric acid), 2% calcined calcium agent (0.1% of calcium oxide), or 5% alcohol agent (0.25% of ethyl alcohol) with subsequent washing with electrolyzed water containing 10 ppm available chlorine. Among the antimicrobial agent treatments combined with electrolyzed water, fumaric acid agent applied on fresh-cut lettuce, alcohol agent on fresh-cut spinach and carrots, and calcined calcium agent on fresh-cut Japanese radish reduced the bacterial counts by 0.8 to 1.5 logs relative to water-dipped control. Treatments had minimal effect on organoleptic quality including wilting, browning, and water-soaked appearance. When fresh-cut vegetables treated with each optimum disinfectant were stored in air or high CO<sub>2</sub> atmospheres at 10 °C for 6 days, high CO<sub>2</sub> of >10% reduced growth of mesophiles or coliforms by 0.5 to 2 logs as compared to those in air and limited the diversity of bacterial flora comprising phytopathogenic organisms such as genera *Enterobacter*, *Pantoea*, and *Pseudomonas* with all fresh-cuts. However, the 15% and 20% CO<sub>2</sub> atmospheres accelerated growth of lactic acid bacteria with fresh-cut spinach, carrots, and Japanese radish, which contributed to detrimental effect on the organoleptic quality such as off-odor. Therefore, a 15% CO<sub>2</sub> for fresh-cut lettuce and 10% CO<sub>2</sub> for fresh-cut spinach, carrots, and Japanese radish would be recommended for the storage of product after disinfectant treatments.

**Monday, August 2, 2010****Springs K & L****Oral Session 8: Marketing & Economics**

3:15–3:30 pm

**Reducing the Risk of Biocontamination in the Production Leafy Greens through Public Outreach, Awareness, and Education**

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An Arizona Leafy Green Marketing Agreement (AZLGMA) outreach campaign was initiated in Yuma, Arizona to educate and inform Yuma area residents about the newly implemented set of food safety safeguards and their critical responsibility within the program. Prior to initiating the informational campaign, over 200 randomly selected area residents were assessed to establish a baseline to better understand the impact of agriculture to the local economy, the AZLGMA, their confidence in leafy green production and general food safety guidelines in the region. Later, an 8-month educational outreach campaign was developed which included a series of 10 food safety public service, television announcements (shown on KYMA-NBC, KSWT-CBS, Yuma 77 and City73), 10 food safety radio (KTTI-FM, KQSR-FM and KBLU-AM) commercials, a youth oriented food safety field day, 4 local newspaper (Yuma Sun) articles and 7 general audience presentations. Prior to the Yuma AZLGMA outreach campaign, the overall awareness of the AZLGMA was negligible with only ~10% of local residents and ~13% of winter visitor were knowledgeable in current food safety guidelines. Approximately 38% of Yuma residents and 56% of winter visitors surveyed were aware of newly adopted food safety standards prior to the campaign. After the AZLGMA outreach promotion, general food safety awareness improved over 50% and 45% for area residents and winter visitors respectively, while overall confidence in leafy production protocols increased 2-fold. While the majority of those that live in the Yuma area during the months of leafy green production are not aware of the AZLGMA by name, area residents appear to be generally more sensitive to and aware of to the new production standards. In general, results of this project suggest that adults over the age of 25 years are more responsive to the needs of the industry than area youth. Moreover, educating youth about area agricultural while expanding their cooperation for field-level food safety mitigation will continue to challenge the Yuma leafy green industry and that specific outreach programs which target youth would be beneficial.

*Specified Source(s) of Funding:* Arizona Department of Agriculture

3:30–3:45 pm

**Assessing Consumer Interest in Value-added Processed Apple Products**

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A total of 507 consumers who were age 21 and older, the primary food shopper for the household, and who resided in the Philadelphia metropolitan area, participated in a 10-minute Internet-based survey (administered 16–22 July 2008) for the purpose of studying consumer cooking and food preparation and potential demand for value-added processed apple products. Results can assist produce industry members with determining which segments of consumers are more likely to purchase such products, and assist with identify value-added apple products that are most likely to appeal. When asked how often participants purchase cut and packaged apples or products made with apples such as juices, baking mixes, sauces, and pastries, the most common responses among all participants was “a few times a year” (35.5%). Participants living in households with two or more children were less likely to select “I do not purchase” processed apple products (16.5%) than participants with one child or living in households without children (24.7% and 32.1%, respectively). Pertaining to specific processed apple products, participants with a gross annual household income of \$50,000 to \$75,999 (40.2%) were more likely to have purchased “breakfast foods made with apples” compared to participants in all other income levels (16.7% to 31.8%). Additionally, participants age 21 to 36 purchased similar or greater quantity of baby food made with apples, apple sauce, apple jelly and jam, or apple butter, frozen apple products, and apple fruit leather, fruit candies, or snack bars made with apples than consumers in other age ranges. Regarding how likely consumers would be to purchase a ready-to-eat food item, those age 37 to 48 were more likely (41.5%) to purchase an item for lunch that “would not need to be heated or reheated” than participants age 21 to 36 and 49 and older. If the lunch item “would need to only be heated or reheated” then consumers age 21 to 36 were more likely to purchase the item (50.7%) than consumers age 49 and older. Participants age 65 and older were among the age groups who expressed that they “would not purchase” these products along with consumers residing in households without children.

3:45–4:00 pm

**Consumer Purchasing Behavior and Attitudes toward Locally-grown and Certified Organic Food Products in the Mid-Atlantic Region**

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Four separate Internet surveys (Nov. 2008–Mar. 2010) were constructed to study purchasing behavior and attitudes towards local and organic products of consumers living in five major cities of the Mid-Atlantic Region. Examined purchasing behavior and attitudes included what types of foods consumers ate, how and where produce was purchased, and what influenced purchasing decisions. Other factors examined include consumer knowledge of what types of produce can be grown in the Mid-Atlantic region, and the seasonality of these types of produce. Total number of consumers who participated in each survey ranged between 1,500 and 1,700. Significant differences were observed between most demographic groups in types of food purchased (e.g., local, organic, conventionally-grown), from where products were purchased (e.g., supermarkets vs. farmers markets), opinions towards locally-grown and certified-organic products (e.g., participants' definition of local and organic), and knowledge of produce origin and seasonality (e.g., what produce can be grown locally, when it can be harvested and available for sale). Among the results examined, differences existed pertaining to what retailers male and female participants reported purchasing food and snacks, with a significantly greater percentage of females (36.4%) reported shopping at farmers markets/on-farm markets/CSAs, versus only 30.4% of males reporting the same ( $p = .048$ ). In addition, the majority of participants reported believing "locally-grown" was defined as "grown in the areas around their metro area" (33.2% of participants) or "grown in their state" (25.7%), and in terms of mileage, the majority of participants selected "26–50 miles" (25.5%) or "51–100 miles" (19.5%). Most participants defined "certified-organic" as "natural" (73.9%), "grown without the use of pesticides" (72.4%), and/or "grown without the use of chemicals" (75.3%). Additionally, when presented with a choice (Option 1: Not Local and Organic, Option 2: Local and Not Organic), the majority of participants preferred locally-grown produce (64.7%) over certified-organic (26.5%). Research implications are to report on these consumer trends to produce industry members in order to determine what types of products should be offered to what types of consumers, how to attract consumers to these products, and to assist agricultural extension personnel in developing public educational programs.

*Specified Source(s) of Funding:* US Department of Agriculture, Specialty Crop Research Initiative

4:00–4:15 pm

### **A Competitive Market Analysis of the U.S. Elderberry Industry**

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Elderberry is a perennial shrub native to North America with a variety of uses and benefits. Elderberry is especially popular for its antiviral properties and recommended for the treatment of influenza. The fruit is used to make concentrate, jams, jellies, syrups and wines. Demand for elderberry fruit and flowers are increasing from winemakers, jelly processors and nutraceutical companies. In contrast to Europe, elderberry is not well known or widely utilized in the U.S. Up-to-date information is lacking with regard to the elderberry market. This research identifies the current status and future trends in the elderberry industry, elderberry market limitations, along with potential opportunities for elderberry producers and processors. A combination of quantitative (mail survey) and qualitative (phone interview) methods have been used. The theoretical model used for the survey and interview development and analysis is based on the Porter Five Forces Model (PFFM) which describes the competitive forces that coordinate and control the market. The PFFM has been used previously to shed light on the chestnut and shiitake mushroom specialty crop markets. Elderberry market participants throughout the U.S. were identified using information from the Internet (e.g., keyword searches for businesses involved in all aspects of elderberry production, Univ websites that offered links to sources of specialty products) and a database was created. Based on 74 mail surveys analyzed (47% response rate), 51 (69%) respondents gross under \$10,000 in elderberry sales while 7 (9.5%) gross over \$100,000. Fresh or frozen elderberries are sold together with a variety of value added products including wine, juice, concentrate, jelly, syrup, extract and supplements. Eighty-one percent sell directly to consumers. Forty-six percent sell their products locally, 25% regionally and 29% nationally. Fifty four percent of respondents indicated demand has increased over the past 5 years, 71% indicated that current demand is steady or strong and 59% stated that demand will increase in the next 5 years. Twenty-four follow-up phone interviews provided in-depth information about the challenges, opportunities and competitive forces in the elderberry industry. Challenges include a limited domestic supply of fruit, few regionally adapted varieties suitable for commercial production, and high labor costs. Additionally, the lack of affordable mechanical harvesting equipment limits future production potential and industry growth. Respondents identified low levels of competition within the industry at the present time. Based on identified market size and demand, opportunities exist to increase the domestic elderberry industry across the value chain.

*Specified Source(s) of Funding:* Univ Research Funds

4:15–4:30 pm

**Measuring Supply Chain Trends in the Packaging of Stem-free Fresh Sweet Cherries: A Sustainable Approach in Package Design, Product Characteristics, and Expectations**

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This study focuses on developing a survey tool to determine and evaluate the current supply chain trends in the packaging of a new fresh product, stem-free fresh sweet cherries. This novel approach is attempted, in order to create a sustainable packaging system for the launch of the cherries. Methods developed during the course of study will likely aid in the development of packaging systems for other produce. The comprehensive, in-depth survey is planned to collect critical information from cherry growers, packers, retailers and consumers. Response variations between genders, ethnicities and age, are taken into consideration. The acceptance of plastics made from natural resources as alternative packaging materials to the petroleum-based ones is explored. Key characteristics such as package design and optimum size, as well as convenience features, like easy-open and re-closability, are examined. Shelf-life and safety expectations versus preferences in packaging technologies, like modified atmosphere packaging, are also points that this study covers.

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

**Monday, August 2, 2010 Desert Salon 4-6  
Oral Session 9: Plant Nutrient Management**

4:15–4:30 pm

**Bobcat Blend: An Economic Analysis of a Student-run Univ Campus Composting Program**

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A Univ cafeteria composting pilot program was created in which students dining individually source-separated their own organic waste at one of the food courts, while mentor students guided them through the process and educated them on the value of organic waste. The food court's organic waste is mixed with other feedstocks at the Univ composting site and then utilized in the campus gardens. Waste audits and an economical analysis demonstrated the value of the operation to the Univ in terms of savings in waste-hauling expenditures. Compost quality was evaluated to determine the value of the compost to the Univ grounds, gardens and greenhouses. Steps used to implement the Univ compost program, the process involved in conducting the waste audit and the results of the compost quality tests will be reviewed.

4:30–4:45 pm

**Large-scale Composting as a Means of Managing *Eichhornia crassipes*, Water Hyacinth**

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Water hyacinth, *Eichhornia crassipes*, is one of the most invasive aquatic species worldwide. Water hyacinth became a nationwide aquatic weed problem during the last century after its horticultural industry introduction to the United States in 1884 at the Centennial Exposition in New Orleans. Different means of management of the invasive species have been implemented in the past including using herbicides and harvesting for various uses such as feedstocks for animals or for use as a fiber textile. The plant has been successfully composted in the past, but a large-scale system had not been investigated to determine if all plant propagules are destroyed in the process. The intent of this study was to determine if composting is an effective means of managing water hyacinth while producing a quality compost product for the horticultural industry. Univ composting site development and coordination of gathering feedstocks in a Univ composting operation will be discussed. Over 22,000 lb of water



hyacinth, 25,000 lb of poultry litter, and 18,000 lb of cafeteria food waste have been collected and used as feedstocks within the composting system. Water hyacinth seed was rendered non-viable at temperatures above 120 °F. Results will include tests for compost quality and water hyacinth seed viability.

*Specified Source(s) of Funding:* Environmental Protection Agency, Texas Commission for Environmental Quality

4:45–5:00 pm

### **Influence of Compost Origin on Chemical and Biological Properties of Compost Extracts and Pak Choi (*Brassica rapa Chinensis* Group) Yield**

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There is growing evidence that compost extract can benefit plant health and yield but a consistency of the effect is a concern. Compost quality plays a major role in extract quality; however, little work has been done to evaluate the effect of compost sources on compost extract quality and subsequent plant response. The objective of this study was to determine chemical and biological properties of compost extracts produced from different types of compost and to examine their effects on plant growth. Five different composts: chicken manure based thermophilic compost (CT); green waste thermophilic compost (GWT); food waste vermicompost (FWV); aged chicken manure based vermicompost (ACV); fresh chicken manure based vermicompost (FCV); and their extracts were evaluated for chemical and biological properties. Aerobic aqueous extract of each compost was applied to pak choi 'Bonsai' grown in peat based media. Mineral nutrients, humic acid, and microbial activity present in each compost extract were generally representative of those properties of the respective compost sources. N and K content in all compost extracts were negatively correlated with C:N and C:K ratio of the compost sources. Humic acid among compost extracts ranged 98.6–550.5 mg·L<sup>-1</sup> in the order of GWT > ACV = FCV > FWV > CT while N content ranged 8.71–328 mg·L<sup>-1</sup> in the order of CT > ACV > FWV > FCV > GWT. Active bacteria and active fungi were higher in the vermicompost sources compared to thermophilic compost. Indole-3-acetic acid was detected only in vermicompost sources. Except for the extract of GWT, all other compost extracts enhanced plant growth compared to control. However, the extracts of ACV and CT positively influenced plant growth to a greater extent than the

other compost extracts. Although N content in CT extract was double that of ACV extract, plant dry weight, root biomass, total root length and root surface area was higher in ACV compared to the CT treatment. This suggests that compost extract effect on plant production is due to the combined contribution of mineral nutrients, organic acid and microbial activity.

*Specified Source(s) of Funding:* USDA Western Sustainable Agriculture Research and Education and Tropical and Subtropical Agriculture Research grant

5:00–5:15 pm

### **Differential Orthophosphate Leaching in Empire Zoysiagrass and Floratam St. Augustinegrass**

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Phosphorus (P) fertilization in low P retention soils can result in P leaching to ground water. This study evaluated the effect of P application rate on orthophosphate leaching (OP) and its relationship with plant P uptake. Floratam St. Augustinegrass (SA) (*Stenotaphrum secundatum* (Walt) Kuntze cultivar *Floratam*) and Empire Zoysiagrass (EZ) (*Zoysia japonica* cultivar *Empire*) were grown in an uncoated sand soil with very low extractable P and low P retention capacity. Phosphorus was applied every 4 weeks at a rate of 0, 0.14, 0.28, 0.56 and 1.12 g·m<sup>-2</sup>. Each treatment was replicated 4 times. Phosphorus uptake, plant dry matter accumulation, and Mehlich I extractable P were determined biweekly during 120 days (May–Aug. 2008). In addition, large plastic lysimeters were used to collect leachates, and the amount of OP leached was measured weekly. A decrease (*P*-value < 0.05) in OP leached with increasing P application rate was observed in SA while OP leached in EZ plots increased with greater P application. Under the conditions of this study, a cumulative P application of P at 3.75 and 1.5 g·m<sup>-2</sup> in SA and EZ, respectively, did not result in an increase in OP leached in comparison to the no P application treatment. Phosphorus uptake rate of SA across treatments and sampling dates was higher (*P*-value < 0.0001) than in EZ. Root biomass in SA and EZ was not different (*P*-value = 0.920); however, root length density in SA was greater than in EZ (*P*-value < 0.0005).

*Specified Source(s) of Funding:* Research assistantship

5:15–5:30 pm

### Effect of Fertilization on Physiological Activity of *Sloanea hemsleyana* (T. Ito) Rehd. et Wilson Seedlings

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*Sloanea hemsleyana* (T. Ito) Rehd. et Wilson (*fangli*) is an ever-green tree in Elaeocarpaceae. It can be planted as an ornamental plant for its lush green foliage and bio-energy plant for its high oil content seeds. To produce this plant commercially, seeds were collected from an elite population in Zhangjiajie National Forest Park (Hunan, China) and germinated in outdoor conditions. When seedlings were 30 cm high, they were transplanted into 400-mL plastic containers with perlite and peat moss mix and fertilized with N, P and K (200, 500, 1000 mg, respectively) at nine combined concentrations. The chlorophyll content increased significantly as the nitrogen concentration went up. However, both high doses of phosphorus and potassium reduced the chlorophyll content. Under the treatments of 500 mg-N + 200 mg-P + 500 mg-K and 1000 mg-N + 500 mg-P + 200 mg-K, chlorophyll content increased 204% and 196% compared to the control at 0.99 mg/g. Fertilization could also stimulate the activity of superoxide dismutase (SOD), peroxidase (POD), and catalase (CAT). The highest activity of SOD was produced also under the treatment of 500 mg-N + 200 mg-P + 500 mg-K, which was 96.6% higher than that of the control (83.5 U/g-FW·min). For POD and CAT activities, the highest values were under the treatment of 1000 mg-N + 500 mg-P + 200 mg-K that were 27.61% and 167% higher than that of the control, respectively. The content of malonyl dialdehyde (MDA) decreased under all fertilizer treatments and the lowest value was under the treatment of 500 mg-N + 200 mg-P + 500 mg-K, which was 15.84% lower than that of the control. Fertilization can promote the growth of *fangli* seedlings and the recommended application is 1000 mg-N + 500 mg-P + 200 mg-K for every 45 days.

Monday, August 2, 2010

Springs K &amp; L

### Oral Session 10: International Horticulture

4:45–5:00 pm

#### Short-term Training for Production of Export Vegetables

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Agricultural professionals including Univ faculty and staff can play a significant role to provide short-term training to farmers in developing countries to enable these farmers to reach crop production and quality goals. CNFA is a USAID sponsored program that provides funding for volunteers to meet this need for short term training. In August 2009, CNFA organized such a training for the MIDAWVE Vegetable Cooperative near Arusha, Tanzania whose members wished to improve their production practices and quality measures for baby corn, snow peas and French beans for export to the EU. Training objectives that were accomplished were: i) land preparation and planting, including appropriate seeding rates and spacing; ii) appropriate timing and application methods of fertilizer applications, and identify additional soil amendments as necessary; iii) best agronomic practices for each crop; iv) identify major pest problems and recommend areas for training and technical assistance; and v) work with CNFA program staff to identify local resources and opportunities to support the MIDAWVE Cooperative project.

*Specified Source(s) of Funding:* WSU Extension; USAID

5:00–5:15 pm

#### International Conference on Horticulture: (ICH-2009)

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The International Conference on Horticulture (ICH-2009) with the theme Horticulture for Livelihood Security and Economic Growth was held in Bangalore, Karnataka State, India, 9–12 Nov. 2009. It was organized by Dr. Prem Nath Agricultural Science Foundation (PNASF), Bangalore in association with Vegetable Science International Network (VEGINET), Bangalore and Univ of Agricultural Sciences (UAS), Bangalore in collaboration with other national and international organizations. The objective of the conference was to develop a plan to guide the development of cost-effective and efficient horticultural interventions to generate additional employment and income opportunities, crop diversifications through increased production and consumption of horticultural crops, provide better food and nutritional security, and improve health status by prevention of non-communicable diseases and micronutrient deficient disorders, all leading to livelihood security of farmers, particularly small and marginal

ones, and overall economic growth in the interest of both producers and consumers. About 750 delegates from 40 countries including Asia and the Pacific, Africa, Central Asia, Europe, Middle East and United States participated in the deliberations of the conference. There were 17 technical sessions including a seminar, covering six theme areas viz; Technological Domain; Institutional and Policy Support: Socio Economic Domains; Producer – Consumer Domain; Technical Cooperation among Developing Countries (TCDC); Challenges and Opportunities in Horticulture - Seminar; Plenary Session: Opportunities and Future Thrusts. A total of 650 presentations, including 35 lead lectures, 250 oral, and 365 poster presentations were given. The Conference recognized horticulture as the second line of defense, with cereals and legumes serving as the first line in the food domain. It was estimated and stated that horticulture 1) significantly supports food security, 2) is the major contributor to nutrition security, 3) promotes good health, and 4) is a source of employment generation—all leading to livelihood security and further economic growth. The recommendations will be presented during the lecture.

*Specified Source(s) of Funding:* PNASF

5:15–5:30 pm

### **Processing, Traceability, and Export Potential of Fruits and Vegetables from Pakistan**

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In Pakistan fruits and vegetables are grown on large scale but due to unavailability of sufficient processing facilities and poor value chain the exports of fresh fruits and vegetables and processed products are very low compared to other countries. In the country fruits and vegetables are grown over an area of 853400 and 253800 ha with an annual production of 7178800 and 3136800 tons respectively; whereas the exports of fruits and vegetables (fresh and processed) are negligible which are less than 10% of the total production. The main reasons for limited export are the lack of awareness about the world food security standards (HACCP, GLOBALGAP, BRC etc.), quality, traceability and marketing system (value chain). Postharvest losses are very high (25–40%) and there are limited processing/value addition facilities; on the other way the nutritional quality of fruits and vegetables are quite good and the commodities are produced organically (very less pesticides, fungicides and fertilizer are used). Keeping in

view the world consciousness about food safety/security and traceability GLOBALGAP certification has gained popularity in Pakistan and until now thirteen (13) Produce Marketing Organizations (PMOs) consisting of 324 individual farmers have attained GlobalGAP certification covering an area of 6046.4 ha (15116 acres) of citrus orchards in District Sargodha. Similarly one Produce Marketing Organization (PMO) comprising an area of 178.53 ha (446 acres) of mango has also attained GlobalGAP certification. Moreover, four other farms naming Ali Tareen Farm, Lodhran, Jamal Din Wali Farm, Rahim Yar Khan, Dhillon Fruit Farm, Rahim Yar Khan and Asim Fruit Farm, Sindh have also obtained GlobalGAP Certification covering an area of 161.94 ha (404.85 acres), 128 ha (320 acre), 77.7 ha (194.25 acres) and 50.60 ha (126.5 acres) of mango respectively. In perspective of the potential and quality of fresh fruits USAID has recently launched a project on Mango Global GAP Certification along with value chain management for Mango; as well irradiation of mango fruit for export to USA according to FDA rules and regulation. Thus Pakistan can provide big opportunity to exporters and processors if they install the processing/value addition system in Pakistan.

5:30–5:45 pm

### **Fruit and Vegetable Production Is One of the Top Five Income-generating Activities in the Rural Areas in Three Districts in Nyanza Province, Kenya**

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Due to the location on or closer to the equator, many countries in sub-Saharan Africa can grow many crops year-round if water is available. There are some crops such as fruits and vegetables that can be grown on a small scale and farmers can get good returns. Some tropical fruits such as mangoes and citrus bear fruits twice a year, corresponding with the two rainy seasons (long and short rains) in Kenya; a family can own a few trees and still get good returns. Vegetables such as tomatoes, collards, and cabbages that tend to mature within a short period of time ( $\approx 3$  months) can be grown twice or thrice in a year. The growers need to control insect pests and diseases in order to get a good crop but there is no spray or production guide that can provide the grower with information about chemical and non-chemical control methods for insect pests and diseases so they depend mainly on advice from the seed suppliers and agrochemical dealers. In Oct. and Nov. 2009, a survey was carried out to assess how the university can work with communities in Bondo, Siaya, and Rarieda districts in Nyanza Province, Kenya, and income-generating activities were one of the issues assessed. Both current and potential income generating activities were assessed by surveying over 250 small-scale farmers from three districts above. In addition to the above, seminars on vegetable production were presented at two sites, one site in Siaya District and another site in Bondo District. Results indicated that agriculture and small businesses are the major income generating activities in the districts. Fruit and vegetable

production (horticulture) is also in the top five income generating activities as indicated by >8% of the participants in the three districts as a current and potential income generating activity. Challenges faced by small scale vegetable and fruit growers in the three districts, which may be similar to other developing countries, will be discussed in this presentation.

*Specified Source(s) of Funding:* Fulbright Grant - Africa Regional Research Program

## Monday, August 2, 2010 Springs H & I Oral Session 11: Crop Physiology: Biofumigation

5:00–5:15 pm

### Mustard Seed Meal (*Brassica juncea*) Biofumigation Controls Dollar Spot (*Sclerotinia homoeocarpa*) In Vitro and Has Low Phytotoxicity to Bentgrass under Field Conditions

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Dollar spot, caused by *Sclerotinia homoeocarpa* F.T. Bennett, is a common disease of turfgrass. It has become particularly problematic on creeping bentgrass (*Agrostis stolonifera* L.) putting greens. Dollar spot resistance to the fungicides Thiophanate-methyl, iprodione, and propiconazole has been observed at a large number of golf courses sampled in Tennessee. An alternative control is needed for this disease. We conducted lab and field experiments to determine if the volatiles produced from Hydrated Indian mustard [*Brassica juncea* L. Czerniak] seed meal can provide a viable bio-control for dollar spot. Lab studies determined that mustard seed meal at 0.05 g·mL<sup>-1</sup> completely suppressed mycelial growth *in vitro* and that the LD50 was less than 0.02 g·mL<sup>-1</sup>. In field studies we demonstrated that the low rates effective for growth suppression (<0.05 g·mL<sup>-1</sup>) *in vitro* were not phytotoxic to established creeping bentgrass. In fact no phytotoxicity occurred until rates exceeded 1.0 g·mL<sup>-1</sup> of mustard meal applied. These results warrant further research to determine if mustard meal can be an effective biofumigation treatment control strategy for managing dollar spot in field conditions.

*Specified Source(s) of Funding:* UT Ag Experiment Station

5:15–5:30 pm

### Biofumigation Potential and Considerations for the Desert Southwest

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The use of biofumigant, or bioactive, cover crops for soil-borne pest suppression is a management tool that has demonstrated, although often inconsistent, success in rain-fed cropping systems. However, less information is available regarding biofumigant cover crop species and their culture in arid regions, including the desert southwest of the United States. While irrigated agriculture can add an additional level of control to water management of biofumigant crops, the unique and diverse cropping systems can simultaneously add a layer of complexity. This complexity creates roadblocks to adoption of biofumigant cover crops, although alternatives to chemical fumigation are desired among agricultural producers. The desert southwest, and specifically southern New Mexico, present unique soil (calcareous, low organic matter), water (salinity, pH), and climatic conditions (24 cm of precipitation/year, high summer temperatures, mild winters, and intense sunlight) that can impact biofumigation protocols adapted for use in other parts of the country. Here, we outline the attributes of a successful biofumigant crop for southern New Mexico as well as the potential pitfalls and considerations that are specific to our unique environment. Some of these considerations include: the biofumigant crop must be a non-host for economically important viruses, nematodes, and soil-borne fungal and bacterial pathogens; high biomass production over winter, high glucosinolate content with a wide range of functional groups to manage multiple pests; a harvestable primary product (ie- broccoli or cabbage); low cost and readily available; and it will not become weedy itself. Initial studies indicate that brassica biofumigant crops can yield up to 5,400 kg/hectare dry weight, over winter successfully, and contribute to significant dicot weed reduction from direct competition in the fall. We use this information to develop a set of protocols that are economically viable as well as an effective management tool for a wide range of soil-borne pests common to the desert southwest. We outline specific recommendations for southern New Mexico, but with potential application to other parts of the country and arid parts of the world.

*Specified Source(s) of Funding:* Hatch and/or state.

5:30–5:45 pm

### Biofumigation with Brassicaceae Cover Crops: Evaluation of Performance in Vegetable Cropping Systems

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Brassicaceae cover crops can perform unique ecosystem functions in cropping systems due to the ability to accumulate large amounts of glucosinolates in their tissue. In addition to other cover crop benefits, Brassicaceae species serve as biofumigants for soil disinfection when glucosinolates are hydrolyzed to isothiocyanates and other compounds after incorporation into the soil. However, current literature suggests performance of Brassicaceae cover crops has remained unpredictable. Understanding conditions that enhance the biofumigation effect of these cover crops would help enhance their ecosystem functions. Therefore, multiple independent field studies were conducted in Michigan between 2003 and 2009 to evaluate performance of Brassicaceae cover crops in various vegetable cropping systems. Cover crops included brown mustard (*Brassica juncea* 'Common brown'), oilseed radish (*Raphanus sativus* 'Defender'), yellow mustard (*Sinapis alba* 'Tilney'), and Oriental mustard (*Brassica juncea* 'Forge'). Vegetable crops tested included celery and onion (on muck soil) and cucumber, summer squash, muskmelon, and eggplant (on mineral soil). Using weed suppression, crop growth and yields as examples of traits of interest, we observed large variations in cover crop performance among cropping systems. Weed suppression in the range of 10 to 40% (mineral soil) and 30 to 90% (muck soil) was generally achieved especially during the first month following cover crop incorporation. However, supplemental weed control was always needed for acceptable weed management. Crop establishment seemed to be a major problem especially with direct seeded species. In 2007, for example, we observed almost 100% loss in muskmelon stand when the crop was seeded within the first two weeks following biofumigation. It appears that under Michigan growing conditions, allowing sufficient time between biofumigation (cover crop residue incorporation) and crop planting is critical. The greatest increases in crop yield (5 to 20%) were observed for celery and onion when biofumigation was conducted in the fall and the cash crop planted the following spring/summer. To optimize beneficial ecological functions of Brassicaceae cover crops, it is critical to take into account the agroecosystem under consideration, the cash crop and planting material (seed vs. transplant), soil type, soil biological properties, timing of biofumigation relative to cash crop planting, cover crop species, and cover crop growth stage. Finally the practice of biofumigation with Brassicaceae cover crops should follow all basic rotational restrictions.

*Specified Source(s) of Funding:* USDA

5:45–6:00 pm

### **Mustard Suppression of Cucurbits without Biofumigation**

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Biofumigation is one mechanism whereby cruciferous cover crops can suppress pests. We and others have sometimes observed suppression of cucurbits that are sown after incorporating mustard cover crops. To test whether this undesirable effect is a consequence of biofumigation or another property of mustards, we performed two tests that varied the intensity of biofumigation before sowing cucumber or pumpkin. In all cases, cucumbers were inhibited under conditions where no isothiocyanate would have been present in the soil. First, we grew Pacific Gold, a high-glucosinolate mustard, and varied the biofumigation by timing incorporation, applying jasmonic acid to raise the glucosinolate level or covering with plastic after incorporation. The inhibition of cucumber yield relative to the no-mustard control was equal in all mustard treatments (23%). Second, we raised low- and moderate-glucosinolate mustard (Tilney, Red Giant) in the spring, sowing cucumbers either immediately (higher biofumigation) or 5 d later. Cucumber yield was inhibited by 65% in the low-GS and 45% in the moderate GS; delaying planting slightly increased the inhibition. Third, a low-glucosinolate mustard (Tilney) was sown in the fall and allowed to winterkill, with two controls, bare ground and a non-biofumigant cover crop, buckwheat. The following spring, the field was sown to cucumbers. None of the treatments would expose pumpkins seedlings to a biofumigant. The fall covers reduced cucumber yield equally (32%). In each of the three tests, the results are inconsistent with the inhibition of cucumbers being caused by biofumigation. Thus there is potential for finding ways to avoid having cover crops inhibit cucumbers while retaining the benefits of biofumigations.

*Specified Source(s) of Funding:* USDA RAMP

**Tuesday, August 3, 2010**

**Springs A & B**

### **Oral Session 12: Citrus Crops 1**

8:00–8:15 am

#### **Premature Fruit Drop due to Huanglongbing Infection in *Citrus sinensis* Is Predicted by Cell Wall Hydrolase Gene Expression**

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Citrus greening, also called Huanglongbing (HLB), is caused by a fastidious, phloem-restricted bacterium, *Candidatus Liberibacter* spp. HLB has been discovered in many major citrus producing countries worldwide and affects all known cultivars. Specific symptoms on HLB leaves are vein yellowing and blotchy mottle. Infected fruit are lopsided, smaller in size, poorly colored and prematurely drop at the calyx abscission zone before fully mature. Trees typically die within 3 to 5 years post-infection. Our study with *Citrus sinensis* 'Valencia' fruit

at the green mature stage indicated 10-fold higher fruit drop in HLB-infected trees compared with healthy trees. The fruit detachment force (FDF) was reduced 75% in symptomatic fruit when compared with healthy fruit. The expression of abscission-induced genes such as *1-aminocyclopropane-1-carboxylate synthase (CsACS1)*, *cellulose-1 (CsCel-1)*, *polygalacturonase (CsPG)*, *phospholipaseA<sub>2</sub>α (CsPLA<sub>2</sub>α)* and *PhospholipaseA<sub>2</sub>β (CsPLA<sub>2</sub>β)* were 17-, 7.4-, 531-, 1.4-, and 1.6-fold induced in symptomatic fruit abscission zones (SFAZ) compared with healthy fruit abscission zones (HFAZ), respectively. There was no difference of FDF between asymptomatic fruit and healthy fruit. However, expression of *CsACS1* and *CsCel-1* were 5-fold increased and *CsPG* was 150-fold increased in asymptomatic fruit abscission zones (ASFAZ) compared with HFAZ. Bacterial titer was higher in SFAZ than ASFAZ. The titer of bacteria was correlated with percentage of fruit drop. These results confirm that abscission is induced prematurely in ASFAZ and SFAZ through induction of abscission cell wall hydrolase genes known to be associated with organ loosening.

8:15–8:30 am

### Naringenin Antagonizes the Invasive Potential of *Salmonella* Typhimurium LT2

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*Salmonella* Typhimurium is a major cause of gastroenteritis. In past years several outbreaks of *Salmonella* infections were recorded including as recent as 2008–09. *Salmonella* infections have become a great economic burden on the society. Moreover, with the rise of antibiotic-resistant strains, it has become imperative to look for new class of antimicrobials. Flavonoids are ubiquitous in plants and comprise significant part of vegetable/fruit based diet. Citrus flavonoids have been implicated in alleviating several chronic diseases such as cancer, cardiovascular disease and neurodegenerative diseases. During our investigations with citrus flavonoids, naringenin demonstrated antagonistic potential against quorum sensing and biofilm in *Vibrio harveyi* and *E. coli* O157:H. In the present investigation, impact of naringenin on *Salmonella* Typhimurium LT2, a notorious food borne pathogen was evaluated. Biofilm,

motility, adhesion and invasion potential of *S. Typhimurium* upon exposure of naringenin were measured. The adhesion and invasion assays were carried out using colonic adenocarcinoma cells SW480. The results indicated that naringenin treatment reduces the motility and the ability of *Salmonella* Typhimurium to attach and internalize into the epithelial cells. The data suggest that consumption of grapefruit may help in prevention against *Salmonella* Typhimurium infection.

*Specified Source(s) of Funding:* Federal Initiative Designing Foods for Health through the Vegetable & Fruit Improvement Center, Grant No. TAES 2008-34402-19195.

8:30–8:45 am

### Performance of Some Exotic Cultivars of Sweet Orange in Punjab, Pakistan

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Citrus industry of Pakistan has been monopolized by a single cultivar Kinnow mandarin. Efforts are being made to diversify the citrus industry by induction of some suitable species like sweet orange, being the best choice after Kinnow mandarin in Pakistan. In the present studies 11 exotic cultivars (Salustiana, Emby Gold, Lane Navel, Glane Navel, Hamlin, Tarocco-N, Casa Garande, Hinkley, Marr's Early, Kozan and Musambi) of sweet orange grown at Citrus Research Institute Sargodha (CRIS) Pakistan, were tested for cultivation in Punjab province. The studies comprised of a wide range of vegetative growth parameters (plant height, plant spread, canopy volume, stem girth) and physiochemical properties (fruit size, per fruit weight, number of fruits per plant, number of seeds per fruit, juice percentage, total soluble solids (TSS), acidity, TTS/acid ratio, peel thickness, peel weight, rag weight) of the fruits. The experiment was laid out according to randomized complete block design (RCBD), consisting of 11 treatments (cultivars) replicated four times and two plants were taken as an experimental unit; the data was collected and analyzed according to standard analytical techniques. The preliminary results showed that Salustiana performed the best in all respects followed by Tarocco and Musambi. On the basis of this study, it can be recommended

that the above said three cultivars (Salustiana, Tarocco-N and Musambi) can be inducted as potential cultivars to diversify the citrus industry of Pakistan.

8:45–9:00 am

### Exogenous Applications of Plant Growth Regulators Influence the Reproductive Growth of *Citrus sinensis* Osbeck cv. Blood Red

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To study the influence of exogenous applications of plant growth regulators on the reproductive behaviour of low bearing sweet orange (*Citrus sinensis* Osbeck) trees, three separate experiments were conducted on 12-year-old 'Blood Red' sweet orange trees budded on rough lemon (*Citrus jambhiri* L.) root stock. In the first experiment, trees were sprayed with 20 mg·L<sup>-1</sup> 2,4-D and GA<sub>3</sub> alone or in combination at mid-bloom (MB) stage, whilst in the second and third experiments 20 mg·L<sup>-1</sup> 2,4-D and GA<sub>3</sub> alone or in combination were sprayed at MB + 6 weeks after MB, and at MB + 22 and 28 weeks after MB stages, respectively. A single tree was selected as an experimental unit and each treatment was replicated four times. Data regarding the flowering intensity, flower drop, fruit set, fruit drop and fruit harvest percentages (%) were collected and analyzed statistically. In all experiments exogenous application of 20 mg·L<sup>-1</sup> 2,4-D and GA<sub>3</sub> alone or in combination to 'Blood Red' sweet orange trees reduced the flower drop % and increased the fruit set % as compared to untreated trees. Application 2,4-D and GA<sub>3</sub> alone or in combination at MB did not affect the fruit drop % and fruit harvest % in contrast to untreated trees. The trees sprayed with 20 mg L<sup>-1</sup> GA<sub>3</sub> alone or in combination with 2,4-D at MB + 22 and 28 weeks after MB exhibited highest reduction in the fruit drop % compared to control trees. In conclusions application GA<sub>3</sub> (20 mg·L<sup>-1</sup>) alone or in combination of 2,4-D (20 mg·L<sup>-1</sup>) at MB + 22 and 28 weeks after MB can be used effectively to increase the fruit set and reduce the fruit drop in 'Blood Red' sweet oranges.

*Specified Source(s) of Funding:* Higher Education Commission of Pakistan/ Punjab Agriculture Research Board

Tuesday, August 3, 2010

Springs K & L

### Oral Session 13: Water Utilization and Management

8:00–8:15 am

#### Impact of Four Irrigation Treatments on Four Shrub Species

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In response to a severe regional drought that afflicted much of Colorado in 2002, Colorado State Univ initiated a study in 2005 to determine the impact of irrigation treatments on some common shrub species. Irrigation treatments were based on the evapotranspiration (ET) of Kentucky bluegrass (KBG). Seven species considered "low water use" or "very low water use" were evaluated 2005–2008. Results of that study were reported at the 2009 ASHS conference. In 2008, four shrub species considered to be more water demanding than the previously studied species were planted: Redosier dogwood (*Cornus sericea* 'Isanti'), Annabelle hydrangea (*Hydrangea arborescens* 'Annabelle'), Diablo® ninebark (*Physocarpus opulifolius* 'Diablo'), and blue arctic willow (*Salix purpurea* 'Nana'). The 2008–2009 study was comprised of an in-field component and a lysimeter component. The in-field component had four treatments based on the ET of KBG, (0%, 25%, 50%, and 100%) and the lysimeter component had three treatments based on the ET of KBG (25%, 50%, and 100%). All four species were planted in the in-field component, and the Redosier dogwood and Annabelle hydrangea were planted in the lysimeter component. Data collection in both components included height and width, visual ratings, predawn leaf water potentials, and end of season leaf area and fresh/dry weights. The in-field component also included infrared readings of the KBG and soil moisture readings. The lysimeter component required daily weight measurements during dry down periods and periodic leaf gas exchange readings. Even after applying treatments that were roughly 0, 0.15, 0.3, and 0.6 gal per shrub per week for the 0%, 25%, 50%, and 100% treatments, respectively, irrigation treatments had little to no impact on all 4 species in the in-field component. Above normal precipitation [~25.4 cm (10 inches)] and cooler temperatures [17.9 °C (64.2 °F)] during the growing season from May–Sept. 2009 may have contributed to the lack of differences. The results of the lysimeter component revealed that both Annabelle hydrangea and Redosier dogwood will use more water if provided with more water. The potted plants that received 100% of ET lost more water on a daily basis compared to the plants that received 25%, and the plants that received 100% tended to be less stressed than the 25% plants.

However, the hydrangeas in the 50% and 100% treatments were equal in pressure chamber readings, suggesting that greater than 100% of ET of KBG may be required to improve growth and performance on this species.

*Specified Source(s) of Funding:* State commodity groups and foundations

8:15–8:30 am

### **Dissolved Oxygen Influences Nutrient Remediation by Floating Wetlands**

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Declining water quality and increasing urban demand for water are driving enactment of regulations designed to limit nutrient release into watersheds. Floating wetlands are potential treatment systems for remediating nutrient-rich water that can be established in existing water basins. This research examined the nutrient remediation efficacy of floating wetlands at three treatment scales. These included 1) a two-stage pond system and 2) a replicated trough system from 2008 to 2009 and 3) a replicated mesocosms study in 2009 that evaluated the impact of dissolved oxygen on plant nutrient uptake. The two-stage pond floating wetland was planted with *Agrostis* sp., *Canna flaccida*, *Eleocharis montana*, and *Juncus effusus* in 2008. In 2009, all species except *E. montana* were used to replant the floating wetland. The replicated trough floating wetlands were planted with *C. flaccida* and *J. effusus* during both growing seasons. The mesocosm study was planted with *J. effusus*. Plant growth parameters (shoot height and root length) were measured on a bi-weekly basis, and water quality parameters (pH, conductivity, dissolved oxygen, temperature, and nutrient concentrations) were monitored weekly. Of the plant species examined, *C. flaccida* and *J. effusus* nitrogen and phosphorus tissue concentrations were highest when normalized for total plant biomass. In all studies, increased water column dissolved oxygen enhanced root growth and uptake of nitrogen and phosphorus. Effluent nutrient concentrations were exceptionally low in the pond and trough treatment systems. Nitrogen concentrations in effluent averaged  $0.12 \pm 0.02$  and  $0.03 \pm 0.01$  mg/L nitrogen for the ponds and troughs respectively, and phosphorus concentrations in effluent averaged  $0.03 \pm 0.01$  and  $0.02 \pm 0.01$  mg/L total phosphorus for the ponds and troughs respectively. Nitrogen and phosphorus removal efficiency was low in the mesocosm study. *Juncus effusus* should not be used in monoculture for nutrient removal, rather mixed plantings should be employed to facilitate nutrient uptake. For low-level nutrient loading, floating wetlands appear to be a viable treatment option; however, at higher loading rates,

they were not as efficient as other treatment alternatives such as constructed wetlands. Additional research is required to further evaluate plant species interactions and their influences on nutrient remediation in floating wetland systems. The understanding derived from these studies will allow for optimization and effective application of this promising remediation technology.

8:30–8:45 am

### **Modeling Actual Evapotranspiration of *Viburnum odoratissimum* during Production from Rooted Cuttings to Market-size Plants in 11.4-Liter Containers**

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Rooted cuttings of *Viburnum odoratissimum* were grown outdoors to market size in 11.4-L containers. Actual evapotranspiration ( $ET_A$ ) of nine plants was determined daily, along with evaporation from three control containers shaded by plastic foliage to mimic plant growth. The first 60 days after transplanting, substrate evaporation accounted for most of  $ET_A$ . Substrate evaporation was generally constant the first 160 days before declining, but still remained around 160 mL/day through harvest at market size.  $ET_A$  increased with growth and generally followed variations in reference evapotranspiration ( $ET_o$ ). Mean  $ET_A$  during most of the production cycle was less than 600 mL/day (11.8 mm based on upper container surface area). With the spring growth flush, mean  $ET_A$  reached 1.3 L/day as plants achieved market size. Mean cumulative  $ET_A$  to produce 90% of measured plants to market size was 155 L or 3.1 m depth per plant based on container surface area. Water need indices, similar to crop coefficients, were highly correlated with percent canopy closure. This correlation offers a straight forward method to model shrub irrigation requirements based on plant size, spacing and  $ET_o$ .

*Specified Source(s) of Funding:* Southwest Florida Water Management District

8:45–9:00 am

### **Measuring Spatial and Temporal Dynamics of Drip Irrigation Applications to Nursery Tree Crops**

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One of the key issues in sensing soil moisture is accurate sensor placement, since it is critical for precision irrigation applications to ensure continuous growth, conserve water and limit nutrient leaching. Precise sensor placement also optimizes data quality (reducing data overload), thereby minimizing the



cost of implementing sensor networks. We are investigating this issue in diverse ornamental production environments, in soil (tree farms) and soilless substrates (container production). Our primary challenge comes from sensing small-volume drip irrigation applications to trees with large root volumes. A study was initiated in spring 2009 to monitor drip irrigation applications on newly transplanted *Acer rubrum* 'Red Sunset' trees, in a Duffield-Ryder Silt loam soil. The soil volumetric water content of three replicate trees was sensed every 15 min with 18 Ech<sub>2</sub>0-10HS (Decagon Devices) sensors in three dimensions, from April through Nov, 2009. Sensors were inserted at 15, 30 and 45 cm depths central to the tree, and at 30 cm either side of the tree, both horizontal (along the row) and lateral (in the row), at a distance of 30 cm from the trunk. The primary first-year objective of the study was to ascertain the movement of irrigation water applied by two drip emitters (each applying 36 mL/min) at 30 cm either side of the trunk in the row. During a dry period between significant rainfall events (8/28/09 and 10/14/09), a total of 320 L water was applied to each tree in 12 irrigation events. Each irrigation was split into 2-4 cyclic events (of equal volume) to see if irrigation duration had a significant effect on water penetration and lateral movement. Four short irrigation events showed significant lateral movement of water into the rootball, compared to two longer irrigation events, at both 15cm and 30 cm depths. The study will continue during 2010, to ascertain whether these observations will change with increasing root density in the soil volume.

*Specified Source(s) of Funding:* ANLA- Horticultural Research Institute; USDA-NIFA Specialty Crops Research Initiative

## Tuesday, August 3, 2010 Springs D & E Oral Session 14: Commercial Horticulture: Extension

8:00–8:15 am

### Plants, Pests, and Pathogens—A Direct Link to the Front Line

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Each year the Departments of Horticulture Science, Entomology, and Plant Pathology at NC State Univ coordinate four 2-hour,

web-based workshops for horticulture agents and Extension Master Gardener Volunteers (EMGV). The most highly rated format includes five minute segments by one extension agent from each of the three climate areas in the state; a 45-minute segment with a featured speaker; and two 30-minute segments on current issues and opportunities, one on Plant Pathology and the other on Entomology. An average of 34 agents, 186 EMGVs and 13 others participated each session. With a grand total of 135 Agents, 745 EMGVs and 52 others. The session, originally broadcast via satellite, is now distributed via Elluminate. Most counties host the program at their office, projecting the transmission to a screen and inviting EMGVs to participate as a group. Many EMGVs link-up to the session on-line from their own computer at their homes. The program has been rated very good to excellent on quality and relevance. One hundred percent of those completing the survey stated that their participation in the program resulted in more environmentally sound pest management strategies being recommended by agents and EMGVs. More than 80% agreed that participation in the program resulted in agents and EMGVs being able to identify circumstances that do not need treatment, and thus reduce the amount of pesticides recommended. Eighty percent of the agents stated that participation in the program reduced the number of questions being forwarded from the counties to the Plant Disease and Insect Clinic. Agents and Master Gardeners increased their knowledge of horticulture, insect identification and management, and disease identification and management. In addition they increased their knowledge of NC State faculty available to assist them. When compared to the previous satellite system, the Elluminate system rated higher on ease of use, effectiveness, convenience, ease of involving volunteers and others as well as cost. "These Elluminate trainings are the most valuable training tool I have participated in throughout the past four years of being an agent", Anonymous survey response.

*Specified Source(s) of Funding:* N/A

8:15–8:30 am

### Development of the "All about Blueberries" Extension Community of Practice (CoP)

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Blueberry producers in many southeastern states are increasing production at a rapid rate. This has been driven by increasing consumer demand for blueberries due to their anti-oxidant, anti-aging properties and superior nutritional quality. Extension support is needed to guide growers in methods to maximize productivity and decrease production costs. There is also a need to connect blueberry producers with local markets. To meet this need, research and extension faculty from across the southeast have joined together to cooperatively build the “All about Blueberries” Community of Practice, which will be hosted by [www.extension.org](http://www.extension.org). Our goals for the newly-formed CoP include using novel, diverse educational methods to help our Community of Interest (CoI) increase blueberry production efficiency and correspondingly increase consumption of blueberries in the southeastern United States. Our CoI is broadly defined as producers (commercial and backyard), distributors, and consumers of blueberries (youth and adult). Our initial focus is southeastern blueberry producers and consumers. Over time, this CoP will be expanded to include grower support materials for blueberry growers throughout the United States. Consumer needs do not vary regionally, so consumer content will be applicable nationwide. The All About Blueberries CoP is comprised of Extension researchers/specialists from Louisiana State Univ AgCenter, Mississippi State Univ, Auburn Univ, USDA-ARS, and North Carolina State Univ who will be creating educational material for the eXtension CoP. An advisory committee has been established that includes blueberry producers, farmers’ market representatives, county agents, Extension specialists, scientists (USDA & Univ), and master gardeners from across the southeastern US. We are currently looking for experts from across the US to help expand our content. This presentation will introduce you to our team of experts and discuss the plans for future expansion of our CoP.

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

8:30–8:45 am

### **Assessing and Enhancing the Economic Viability of a Home Garden**

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Hobby gardeners striving to produce fruit, vegetable and herb crops in home gardens rarely obtain crop yields or quality sufficient to offset the cost of inputs and labor required to produce the garden. This project addressed the question: can a home garden be made more economically sustainable by using appropriate management practices including; 1) soil amendments, 2) optimum site selection for each crop, 3) crop and cultivar selection, 4) irrigation, 5) optimum pruning, training and harvesting techniques, and 6) effective disease and pest control methods. Fifty different fruits, vegetables and herbs were grown over the 2004, 2005 and 2006 growing seasons in a 118.53-m<sup>2</sup> urban garden in the city of Toronto, Ontario, Canada. Crop yields, quality and flavor characteristics as well as susceptibility to disease and pests were recorded. Cost of production, total gross revenue and profits were calculated for each crop and for the garden as a whole. Although most crops tested could be grown successfully under the conditions available within the garden, a more limited number produced yields sufficient to offset the cost of production (materials + labor @ \$8 CDN/h). Carrots, cauliflower, tomatoes, lettuce, eggplants, peppers, spinach, Swiss chard, blackberries, raspberries and nearly all herbs were all profitable. Selecting the most appropriate crops, cultivars and production techniques allowed the profitability of the garden to increase with each growing season. Crop value and profitability were calculated as (value = yields\*average price at nearby farmers markets) (profitability = value – costs of production). The study showed that well managed urban gardens could represent an economically sound method of producing food that also enhances the biodiversity and aesthetic appeal of the urban environment.

*Specified Source(s) of Funding:* Robert P. Knowles Scholarship

8:45–9:00 am

### **Online Database for Peach Germplasm Evaluation**

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A MySQL database was created to enter data from our long-term peach germplasm evaluation program at Clemson Univ. This database is updated on-line and is linked to our peach germplasm evaluation website (<http://www.clemson.edu/hort/Peach/index.php?p=73>). Peach evaluation data that is collected in the field and the lab throughout the summer is uploaded to the database within 24 hours and is readily accessible to our online clientele. Our website is regularly utilized by consultants, growers, researchers, extension specialists and agents throughout the U.S. and in several foreign countries. Currently, the database includes up to 10 years of data (2000–09) depending on the cultivar or numbered selection. The database includes the following information for each individual record:

year, location, cultivar or numbered selection, ripening season, flesh color, chill hour requirement (if available), bloom date, ripe date, set (% of full crop), size (average diameter), shape, pubescence, red skin coloration, attractiveness, flesh firmness (average puncture pressure), freeness of stone, overall status, brix (average soluble solids concentration), evaluation notes, and full description if available (from formal release or issued patent). Linked to each individual record is a digital image of the fruit at the time of harvest. All fruit photographs are taken on a standard 1 inch x 1 inch grid background that includes six fruit views per sample (stem end, tip end, suture side, non-suture side, longitudinal section and cross section). A powerful search feature allows searching across all records in the database. In addition, a side-by-side comparison feature was created to make possible direct comparisons on the screen. This database allows growers to do their own homework and fine-tune their decision making about choosing new cultivars for future plantings. Specialists and county agents and others use the site to familiarize themselves with cultivars used in the trade or make recommendations themselves.

*Specified Source(s) of Funding:* Cooperative Extension Service and USDA-CSREES-SCRI

9:00–9:15 am

### **A Program to Develop Sweetpotato Production for Small Farms in Kentucky Appalachia**

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Farming in rural eastern Kentucky has traditionally been based on burley tobacco production. However, recent shifts in marketing and the production of burley tobacco have resulted in many growers looking for alternative crops. Horticulture crops are of particular interest to growers in this region because they offer relatively high rates of return with limited production acreage. However, many horticulture crops require significant capital investment, high levels of management or specialized markets for sale. Sweetpotatoes represented a crop with that would require relatively little capital investment, as they could be planted one bare ground using traditional tobacco equipment and required a lower level of management than many other horticultural crops. In the Spring of 2009 a Southern SARE funded program was initiated at the Univ of Kentucky in collaboration with the Cooperative Extension Services of Morgan and Elliot Counties in Kentucky to develop production and marketing information for sweetpotato production in Eastern region of the state. In the first year of the project growers formed the East Kentucky Sweetpotato Growers Association to gain purchasing power and to facilitate the development of wholesale contracts. A sweetpotato short course was also offered to participants. This course covered production and marketing practices. Grant funds were used to offset the cost of purchasing sweetpotato slips and

supplies for 11 participating growers as well as reimburse travel costs for several growers and area extension personnel to visit successful sweetpotato farms in North Carolina. The grant funds allowed interested farmers to be involved with sweetpotato production with minimal risk during the first year of production. Yields were evaluated at several locations throughout the state for three varieties: 'Covington', 'Beauregard', and 'O Henry'. 'Beauregard' typically had the highest yields and allowed for the earliest harvest of the three. Harvest date is important for sweetpotato production in eastern Kentucky, where the growing season is significantly shorter than in the remainder of the state. Two sites were provided with drip irrigation, to evaluate the worth of providing supplemental irrigation. In 2009, irrigation had no effect on yield. Typical yields for Beauregard approached 1000 boxes/ha. Growers set prices at \$20 per 18-kg box and sold to retail and wholesale markets. Returns were high for most participants and several growers plan to expand their acreage in the upcoming season. The results of this program suggest that sweetpotatoes represent a viable alternative crop for small farms in eastern Kentucky.

*Specified Source(s) of Funding:* Southern SARE

9:15–9:30 am

### **Impact of a Specialty Cut Flower Workshop on Attendees' Actions to Implement Risk Management Strategies**

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A collaborative team from multiple states implemented a workshop in Nov. 2009 for stakeholders interested in specialty cut flower production. The project was supported by a grant from the Southern Region Risk Management Education Center. The overall goal of the workshop was to help interested parties gain an understanding of the production and marketing issues associated with small-farm production of specialty cut flowers and to assist growers to better manage risks associated with this type of activity. Assessment tools were used at the beginning and end of the workshop, and again 4 months later, to document impact of the workshop on the decision making process of attendees. The workshop attracted an audience from 23 states. A majority (77%) of the attendees were existing growers and 78% reported their operation was 5 acres or less. Season extending technologies were used by 68% of the growers. The primary (67%) marketing channel for these growers are farmers markets. At the end of the workshop 97% of attendees indicated they will improve the way they manage risks in their operation as a result of attending the workshop. A follow-up survey is documenting how many

attendees implemented changes in risk management strategies four months after the workshop.

## Tuesday, August 3, 2010 Springs H & I Oral Session 15: Floriculture 1

8:00–8:15 am

### Effects of Fertilizer Source and Rate on Zinnia Cut Flower Production in a High Tunnel

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This study evaluated the effects of pre-plant compost incorporation and fertigation with different levels of conventional and organic fertilizers during the growing season on zinnia (Benary's Giant Mix) plant growth and number of cut flowers produced in a high tunnel. The study was arranged as a 4 × 5 factorial, with a split plot design. The main plot was one of four pre-plant compost applications: composted broiler litter, vemicompost, cotton gin compost, and control (no compost). The compost rate used was 4 tons/acre and the compost was incorporated into the bed before laying the plastic mulch. Under each compost treatment, there were five fertigation treatments: no fertilizer, organic low [100 ppm nitrogen (N) from MultiBloom], organic high (200 ppm N from MultiBloom), conventional low (100 ppm N from Peter's 20–10–20), and conventional high (200 ppm N from Peter's 20–10–20). Each treatment combination included 10 zinnia plants which were planted half ft apart with two parallel rows on one bed. Each treatment combination was replicated 3 times. Plants were transplanted into the beds in early April and each plant was supplied with 200 mL of solution from each fertigation treatment once a week for one month and then twice a week from May through September. Zinnia stems were harvested as soon as the blooms were completely opened, starting from mid-May through September. The number of stems longer than 12 inches was recorded. Results indicated that the pre-plant compost had significant effect on leaf SPAD reading and plant growth index during early stage of plant growth, and plants that received composted broiler litter had significantly higher SPAD reading and plant growth index than other treatments; however, pre-plant compost had no effect on the total number of stems produced. Plants that fertigated with high rate of organic fertilizers produced similar stems as plants treated with conventional high, but more stems than lower rates of either conventional or organic

fertilizers. Plants that did not receive any fertigation produced the lowest number of stems. This study shows that growers can have summer long production of zinnia cuts in a high tunnel in Mississippi. The data also shows that similar levels of N from either the conventional or organic fertilizer tested in this study can produce similar number of zinnia stems.

8:15–8:30 am

### Identifying Optimal Fertility Rates for Sustainable Floriculture Production

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During bedding plant production, fertilizer nutrients are often leached from the media and may cause environmental contamination. Fertilizer recommendations should be adjusted to meet plant requirements and maintain quality while minimizing waste. Such an approach reduces fertilizer use and enhances environmental stewardship. On the other hand, the issue of plant quality is a concern when modifying a fertility program. While dry weight provides a means of comparing plant growth, it is not the only factor that contributes to plant quality. Four quality aspects, including leaf greenness, flower count or flower dry weight, total dry weight, and consumer preference ratings were measured to identify an ideal rate for four fertilizers under typical production conditions. *Catharanthus roseus* 'Salmon', *Celosia argentea* 'Grow Red', and *Impatiens hawkeri* 'Paradise New Red' were grown in a rate experiment using two granular and two water-soluble fertilizers: 1) Contec-DG® 15N–3.9P–9.9K at rates of 1 kg·m<sup>-3</sup>, 2.14 kg·m<sup>-3</sup>, and 3.57 kg·m<sup>-3</sup>, top-dressed, and 2) Osmocote® Plus 15N–3.9P–9.9K, 3–4 month longevity at rates of 3.56 kg·m<sup>-3</sup>, 5.33 kg·m<sup>-3</sup>, 7.11 kg·m<sup>-3</sup>, top-dressed; 3) Daniels® 10N–1.8P–2.5K and 4) Peters Peat Lite® 20N–4.4P–16.6K fertigated at rates of 75 mg·L<sup>-1</sup> N, 150 mg·L<sup>-1</sup> N, and 250 mg·L<sup>-1</sup> N. Raw data were transformed to fit a scale of 0–5 for each quality aspect to yield a total quality index. Data analyses of the quality aspects were conducted using linear regression. Significant differences between the quality indices were identified using ANOVA and LSD ( $\alpha = 0.05$ ), which allowed for determination of the minimum rate observed at which the maximum quality rating was obtainable. 'Optimal' rates were determined to be as follows: Contec-DG®: 2.14 kg·m<sup>-3</sup> for *C. roseus* and *I. hawkeri*, 3.57 kg·m<sup>-3</sup> for *C. argentea*; Osmocote® Plus: 5.33 kg·m<sup>-3</sup> for *C. roseus* and *C. argentea*, 7.11 kg·m<sup>-3</sup> for *I. hawkeri*; Daniels®: 150 mg·L<sup>-1</sup> N for *C. roseus* and *I. hawkeri*, 250 mg·L<sup>-1</sup> N for *C. argentea*; Peters Peat Lite®: 150 mg·L<sup>-1</sup> N for *C. argentea* and *C. roseus*, 75 mg·L<sup>-1</sup> N for *I. hawkeri*. These fertility rates will be used for further comparison of the effect

of the fertilizers on leachate nutrient content, tissue nutrient content, and plant quality.

*Specified Source(s) of Funding:* Department of Horticulture and Crop Science/OARDC

8:30–8:45 am

### **Media Containing Bark or Parboiled Rice Hulls Affects Plant Growth Retardant Drenches Differently**

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The application of plant growth retardants (PGRs) is common in floriculture production to produce uniform, compact, and marketable plants. While peat, perlite, and vermiculite are common substrate components, bark and rice hulls are being used as alternative, and sustainable media components for soilless substrates. The objective of this study was to evaluate the impact of media components on efficacy of PGRs drenches applied to bedding plants for height control. ‘Callie Deep Yellow’ calibrachoa and ‘Delta Orange Blotch’ pansy were planted in 11.5-cm pots filled with peat and perlite-(PP), peat and parboiled rice hull-(PRH), or peat and pine bark-based (PB) media. After planting, 74 mL of deionized water, paclobutrazol, or uniconazole solutions were applied to the media surface of each treatment. Paclobutrazol (2.0 or 4.0 mg·L<sup>-1</sup>) and uniconazole (1.0 or 2.0 mg·L<sup>-1</sup>) drenches suppressed calibrachoa stem length for plants grown in each media. However, at each paclobutrazol concentration and for 1.0 mg·L<sup>-1</sup> uniconazole, control of stem elongation was reduced for plants grown in PB media compared to PP media, while there were no differences between treated plants grown in PP and PRH media. Similarly, pansy plant height was comparable for plants grown in PRH and PP media and treated with 0.5 or 1.0 mg·L<sup>-1</sup> paclobutrazol or 1.0 mg·L<sup>-1</sup> uniconazole, while plants treated and grown in PB media were taller than treated plants grown in PP media. Based on these results, rice hulls can be used as a media component in combination with PGR drench applications without altering rates used for peat and perlite-based media, because they do not reduce PGR drench efficacy.

8:45–9:00 am

### **Production Shade Levels Affect Yield and Vase Life of *Elaeagnus***

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Producers of cut foliage need information on proper production shade levels to maximize yield and quality. This experiment was conducted to determine the effects of 0, 30, 50, or 80% shade

on stem production and vase life of *Elaeagnus × ebbingei* ‘Gilt Edge’ and *Elaeagnus pungens* ‘Maculata’. The experiment was conducted in central Florida where the majority of U.S. cut foliage production occurs. *Elaeagnus* were planted in Apr. 2005 and harvested periodically from Oct. 2006 through 2009. Stems used for vase life determinations were stored at 4 °C for 2 weeks and then held in glass containers filled with deionized water. Containers were held in rooms that simulated the home/office environment. Vase life was terminated when stems showed signs of desiccation, chlorosis, necrosis or leaf drop. Significant cultivar × shade interactions occurred for yield (numbers and fresh weights of marketable stems). For Gilt Edge, more stems were produced under 30% and 50% shade than under lesser or greater shade, i.e., the response to shade was quadratic. For Maculata, yield declined linearly with increasing shade. Yields for Maculata were consistently more than for Gilt Edge, averaging 76.5 vs. 14.5 stems per plant. Production shade level had variable effects on subsequent vase life. Overall, Gilt Edge vase life was not affected by shade level but the vase life of Maculata stems tended to increase linearly with increasing production shade level. Vase lives varied from harvest to harvest but always were longer for Maculata than Gilt Edge. For all harvests, the average vase lives for Maculata and Gilt Edge were 24.3 and 12.6 days, respectively. Also, vase lives for both cultivars increased over time as the plants became better established. The results indicate that producers of Maculata can use shade to increase vase life but at a cost of reduced production. However, vase lives of Maculata stems grown in full sun averaged from around three to over 5 weeks in 2008 and 2009, respectively, suggesting that, at least for some markets, increasing the vase life using shade may not be necessary.

*Specified Source(s) of Funding:* Florida Agricultural Experiment Station

9:00–9:15 am

### **Impact of Selected Sustainable Production Practices on Poinsettia Quality and Consumer Preferences**

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As more greenhouse producers look into using sustainable practices, information is lacking about how these practices impact crop performance or consumer preferences. Poinsettias produced using organic media, clay additives that provide wetting agent and water retention characteristics, and bioplastics were compared to conventionally-produced plants. The first objective of this experiment was to determine how Mg-mica addition influences poinsettia growth and quality, use of nutrient management tools (pH and EC), and water use (irrigation frequency and quantity) compared to plants produced in standard organic and conventional media. The second specific objective was to compare consumer preference and price-willing-to pay for poinsettias that are of equal quality, but produced using conventional versus sustainable production practices. A split plot design where poinsettia cultivars were the main plot and

sustainable treatments were the subplots was used for this experiment. Sustainable treatments consisted of 1) Fafard # 2 without Mg-Mica in plastic 6-inch azalea pots (Control), 2) Fafard #2 with Mg-Mica in plastic 6-inch azalea pots, 3) Fafard Organic without Mg-Mica in OP47 6-inch bioplastic pots, or 4) Fafard Organic with Mg-Mica in OP47 6-inch bioplastic pots. All other production practices were consistent across treatments. Data collected during production included the number of irrigation events per treatment, pH and EC of leachates, plant growth parameters, and plant quality. Upon maturation, plants from treatments 1 (conventional) and 4 (sustainable) were placed in a consumer preference survey. The number of irrigation events varied by treatment early in production with the Mg-Mica treatments being irrigated less often than those without the supplement. Leachate measures remained relatively flat for pH with a trend downward for EC across all treatments during the production cycle. Plants in Fafard #2 were slightly larger than those in Fafard Organic media. When given the choice of a sustainably produced plant or conventionally produced plant, consumers chose the sustainably produced plant 70% of the time. While 3% of consumers surveyed indicated that they would not pay more for a sustainably produced plant, 32%, 49%, 8%, 4%, and 3% of consumers indicated a willingness to pay the same, up to 15%, 30%, 45%, or 60% more for a sustainably produced plant, respectively. Consumers surveyed indicated a willingness to pay higher prices for plants that were organically produced, locally produced, used biodegradable pots, or had efficient water use during production. The use of sustainable production practices is gaining momentum with producers and clients.

9:15–9:30 am

### **Cultivar and Pinch Date Effect Poinsettia Leaf and Cyathium Retention in a Simulated Post Production Environment**

Rebecca Schnelle\*

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Post production quality loss is a major issue for poinsettias (*Euphorbia pulcherrima* Willd. ex Koltzsch) marketed through the modern market chain. Growers face increasing pressure to produce quality plants with ever tightening profit margins, so reducing production costs without sacrificing product quality is vital. One potential cost saving strategy is producing poinsettias on a shortened production schedule which relies upon reduced vegetative growth time. An experiment was designed to determine the effect of this reduced vegetative growth time on post production quality loss of pinched poinsettia plants quantified by loss of leaves and cyathia. Rooted cuttings of poinsettia cultivars 'Freedom Red', 'Prestige Early Red', and 'Advent Red' were potted into 15-cm pots on 12 Aug. and pinched 4 Sept. or potted 19 Aug. and pinched 11 Sept. 'Freedom Red' plants were grown with natural day length in Lexington, KY. Night interruption lighting was used to delay 'Prestige Early Red' (lights out 25 Sept.) and 'Advent Red' (lights out 1 Oct.). With this schedule all 3 cultivars were at a marketable stage of floral development on the pre-determined simulated shipping

date of 21 Nov. Plant growth regulators were used as needed. All plants in the study were between 35 and 41 cm tall on 21 Nov. Those plants that were pinched on 11 Sept. showed reduced leaf retention compared to those pinched on 4 Sept. following 18 days in a simulated post production environment (indoors under fluorescent lighting). For example 'Freedom Red' plants pinched 4 Sept. and 11 Sept. retained 78% and 71% of leaves present on 21 Nov., respectively. Plants with leaf retention below 75% were considered unmarketable. There was also variability in leaf retention among the cultivars tested. Plants of 'Advent Red', 'Freedom Red', and 'Prestige Early Red' pinched 4 Sept. retained 84%, 78%, and 67% of leaves present on 21 Nov., respectively. There was no significant effect of potting and pinch date on cyathia retention so data were pooled for each cultivar. After 18 days in the simulated post production environment 'Advent Red', 'Freedom Red', and 'Prestige Early Red' plants had dropped an average of 0.4, 0.9, and 4.5 cyathia per lateral branch. The vegetative time allotted for poinsettia crops as well as the cultivar selected have a clear impact on the plants' leaf and cyathia retention in post production.

Tuesday, August 3, 2010

Springs A &amp; B

### **Oral Session 16: Production & Harvest Mechanization**

9:30–9:45 am

#### **Increasing Nursery and Greenhouse Worker Safety**

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The activities performed by workers in nursery and greenhouse environments are repetitive, tedious and demanding in terms of conditions and tasks performed. The protection of worker safety will help ensure an available motivated workforce. In many cases, the integration of mechanization has helped increase the safety of some nursery operations; provided the equipment is properly used. Some nursery tasks remain primarily manual due to the nature of the work and the limited availability of equipment to offset manual effort. The activities described in this paper target

worker safety improvement for operations involving various pieces of common nursery equipment and mechanization as well as those operations that remain primarily manual. Most options for nursery and greenhouse worker training are limited to either on-the-job training performed by pairing a new employee with a seasoned veteran or general “non-industry-targeted” training. A need was identified for green industry specific training in areas which included Ergonomics, Environment and Equipment. This need was recognized during the completion of a nursery systems engineering analysis of large and small container production nurseries across the Gulf South. This systems analysis utilized a top down approach that viewed the nursery system as a whole; which allowed for the identification of each unique nursery process including detailed process requirements and system inter-relationships. Knowledge of detailed process requirements allowed for safety evaluations to be completed which led to the creation of specific nursery training modules. Research shows that a focus on safety improvements will offer an additional benefit to the overall efficiency of a system. Efforts made to improve the level of safety for a particular nursery operation will increase the worker productivity as well. In addition to addressing safety concerns identified during the systems analysis, efforts were made to help ensure gains in productivity will be realized as these training modules are used. The goal of this study was to create a set of nursery worker training modules targeted at green industry workers. The DVD format was selected as the primary method of delivery offered in English and Spanish. Discussions with nursery and greenhouse owners indicated that these modules would be used to support both new worker orientation and periodic safety refresher meetings with all nursery and greenhouse workers. On-line versions of the training segments are also offered.

9:45–10:00 am

### **Precision Irrigation and Nutrient Management for Nursery, Greenhouse and Green Roof Systems: Sensor Networks for Feedback and Feed-forward Control**

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We have established a national transdisciplinary team to reduce irrigation water consumption and improve nutrient management in greenhouse and nursery production and monitor green roofs, while enhancing system performance, crop growth and quality. We are using a systems-based, multi-disciplinary approach to implement wireless sensor networks in orchard-type (field) environments, in ‘open’ nursery container-production and green roof systems, and ‘closed’ greenhouse environments. This presentation will provide a global overview of the project and the major objectives, including 1) developing the next generation of sensor networks and customizable software to meet irrigation monitoring and control requirements at the species level; 2) determining the performance and utility of moisture sensors for precision irrigation and nutrient management; 3) addressing spatial and temporal variability issues to optimize the numbers of sensors; 4) integrating micro-scale data with macro-scale models to predict short-term plant water use; 5) developing best management practices for irrigation and nutrient management

monitoring, working with specialty crop partners to capture needs-based issues during on-farm system development; 6) quantifying improvements in water and nutrient management, nutrient runoff, plant quality and yield; 7) evaluating the private and public economic and environmental impacts of precision sensor-controlled practices, and identifying barriers to adoption and implementation of these practices. The outcome will be a commercially available product for irrigation water management that is designed for diverse, intensive production environments, but broadly applicable to all high-value specialty crops.

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

10:00–10:15 am

### **Enhancing Labor Performance of the Green Industry in the Gulf South**

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In 2004, Mississippi State Univ's Coastal Research and Extension Center in cooperation with the U.S. Department of Labor embarked on a project comprised of both the determination of needs and the creation or transfer of technologies to meet current and projected industry requirements for labor in the Green Industry. The greenhouse and nursery industry is one of the fastest growing sectors of the I-10 corridor region's agricultural economy; however, a major problem facing this industry is a shortage of workers, particularly skilled workers. A national survey of commercial nursery/landscape operations listed shortage of labor as the number one limitation facing the industry at the end of 2001. The shortage continues today. The geographic focus of the project was the greenhouse and nursery industry of 8 of the 12 states in the Southern United States, namely Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, and Tennessee. The first priority of this project was the creation of new knowledge and technology-based jobs and improved worker safety and comfort. Adoption of this technology will improve working conditions for greenhouse and nursery workers, increase worker retention, improve worker safety, increase worker productivity, improve skill levels, and create new jobs related to servicing the machinery and instrumentation. The Coastal Research and Extension Center, in cooperation

with industry leaders representing the Gulf South, identified several major areas of program focus. Together, we developed a comprehensive set of production issues to be addressed through the integration of applied mechanization technologies developed through this project. The overall objective of this project was to develop novel mechanization and automation technologies which will enable an increase in worker capacity and skill level. Worker safety and comfort may also be improved through the introduction of new mechanization innovations. Nursery workers' skill levels, wage rates, safety, and overall job satisfaction will be increased. With these improvements, the labor shortage currently facing the nursery industry will decrease and worker retention will increase. More specifically, there were five focus areas being addressed through this project: 1) to examine all aspects of nursery production for automation potential, 2) to develop technology for automation of the green industry to increase worker capacity, 3) to increase automation through technology transfer, 4) to increase worker safety and comfort through the use of automated technologies, and 5) to determine the socio-economic impact of these technologies on green industry owners and workers.

*Specified Source(s) of Funding:* U.S. Dept. of Labor - Employment Training Administration

### **Tuesday, August 3, 2010 Springs H & I Oral Session 17: Undergraduate Student Oral Competition**

10:00–10:15 am

### **Alyssum Flower Mutagenesis: Ornamental Crop Improvement**

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Alyssum (*Lobularia*) is a common ornamental flower used in urban and commercial landscapes in many parts of the United States. The white umbuliferous flowers are aesthetically appealing and produced all season. Unfortunately, the flowers are small and stems can be long and gangly. Improvements through increased flower size with a more compact plant growth are desirable and possible through mutation breeding. In this study, four triflurilin treatments (0.0086%, 0.086%, 0.86%, and 1.63%) were applied topically to the meristematic tissues of 260 young Alyssum cuttings. Plants treated with 0.86% and 1.63%



triflurilin showed greater tissue damage and stunted growth but did not die, while those treated with 0.0086% and 0.086% had little tissue damage or stunting. Two weeks following triflurilin treatments, plants in the 0.086% and 0.86% treatments began to show new tissue growth. Within another week, new growth on the 0.086% and 0.86% treatments showed phenotypic signs of mutation and ploidy doubling that included larger and darker green leaves. Cuttings of new (suspected polyploid) growth from 0.86% and 0.086% treatments were taken and re-rooted one month after original treatment. Two months after treatment polyploid mutants were identified through flow cytometry and had twice the amount of DNA when compared to nontreated plants. Treatment with 0.86% produced the most polyploid plants. Three months after treatment polyploid flowers were cut and measured for diameter and pedal width. Nontreated flowers were also measured and the mutant flowers were 0.835 mm (9.43%) larger than their control equivalents. To reduce stem length, Alyssum calli were induced and then treated with ethyl methanesulfonate (EMS). Plantlets from EMS treated calli were separated and grown in the greenhouse.

*Specified Source(s) of Funding:* Brigham Young Univ

10:15–10:30 am

### **Determining the Potential for *Penstemon barbaris* and *Canna glauca* in Horizontal Sub-surface Flow Wastewater Treatments**

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Constructed wetlands offer communities, companies and homeowners aesthetically pleasing and effective treatment possibilities for their wastewater. Plant choices play a large role in the success of a constructed wetland, offering both physical presence and toxin stabilization. The Univ of Maine chapter of Engineers Without Borders is working on designing a horizontal sub-surface flow wastewater treatment system in Dulce Vivir, Honduras. The plants chosen needed to be native to Central America, and tolerant of both wet and dry conditions, high porosity media, and wastewater exposure. *Canna glauca* and *Penstemon barbaris* were grown in closed systems with effluent from the Orono, ME, Wastewater Treatment Plant to simulate the conditions of a constructed wastewater wetland with one of the following treatments: 0% effluent, 50 % effluent, and 100% effluent. Salinity (measured as electrical conductivity) increased 61.9% from 0.39 mS·cm to 0.63 mS/cm in 0% to 100% effluent respectively for *P. barbaris*, and increased 52.9% from 0.37 to 0.70 mS·cm<sup>-1</sup> in 0% to 100% effluent respectively for *C. glauca*. Despite the changes in salinity, all of the plants survived and grew equally well as measured by height, width and root length. The project demonstrated that *C. glauca* and *P.*

*barbaris* are good candidates for constructed wetlands through their survival and performance in the experiment.

10:30–10:45 am

### **Evaluating Fungal Endophyte Isolation Techniques in Three Grape Species**

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Endophytes are either fungal or bacterial organisms living within plant tissues. Most plants which have been evaluated for the presence of endophytes have been shown to host endophytes. The characterization and function of bacterial endophytes in wine grapes and their relation to certain plant pathogens have been examined. However, research investigating the role of fungal endophytes in grapes is limited. Our objective was to evaluate different methods for extracting fungal endophytes from grape leaf tissue leading to the development of efficient extraction protocol. We collected fresh leaf samples from three different grape species; *Vitis cinerea*, *V. aestivalis*, and *Vitis X 'Chambourcin'*. Leaf tissue from each species was subjected to three surface sterilization techniques (dips in EtOH followed by 2.5, 5, and 10 minute dips in NaOCl.) Following surface sterilization, leaf tissue was exposed to three different antibiotics (streptomycin, neomycin, and ampicillin) in the growing media). There were six replications of each treatment, and the growing media was a 1% malt extract agar (MEA). The Petri dishes containing the leaf tissue and growing media were placed in a 21°C environment and checked weekly for 4 weeks for the presence of fungal growth. Data were recorded on the presence or absence of fungal growth, and the levels of contamination. Data from the experiment were subjected to analysis using SAS® statistical software. Our findings provide new insight into techniques useful for fungal endophyte extraction in *Vitis* spp.

*Specified Source(s) of Funding:* Middle Tennessee State Univ, Undergraduate Research Experience and Creative Activity (URECA) Grant

10:45–11:00 am

### **A Comparison of Conventional and Granular Manure Organic Fertilizers**

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During the recent decade, organic farming has gained increasing interest as an environmentally friendly production system

because of its positive effects on the environment. While many investigations have focused on the conversion to organic forms of fertilizer, some studies involving organically derived nutrients have suggested a level of discrepancy between nitrogen (N) losses (via leaching and volatilization) and the subsequent availability of N to plants. The general intent of this effort involves a relative comparison of conventional fertility management schemes with a heat treated granular manure product (EarthRenew, Inc.). During the first year (2009), research was devoted to establishing nutrient and plant development baselines, based solely on preplant applications of the granular manure product at planting. Evaluations of overall nutrient persistence using soil or plant tissue nutrient and crop condition at maturity were used as indicators. Prior to all fertilizer applications, preplant soil analysis for N and P was determined. With the exception of nutrient management, experimental crops (Iceberg lettuce, leaf spinach and broccoli) were grown according to typical grower production practices with respect to irrigation and pest management in Yuma, AZ. In general, the granular manure performed equal to conventional fertility management programs in spinach, a crop which has a short growth period. However, in crops which required longer periods of time to mature and where fresh cut quality is a premium (i.e. lettuce and broccoli), the level of nutrients derived from the organic product appeared insufficient to finish the crop when compared to conventional grower practices. As a result, additional studies during the 2010 season will include studies involving midseason applications of the organic product to long duration crops. If organic fertility shortfalls can be addressed in long duration crops, there seems to be significant potential for the granular manure product in the fresh cut organic produce industry. Results of this 2-year study will be discussed.

*Specified Source(s) of Funding:* EarthRenew, Inc.

11:00–11:15 am

### **Morphological Variation in Plants Derived from In Vitro Culture of ‘Laura Bush’ Petunia**

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‘Laura Bush’ petunia, *Petunia xviolacea* ‘Laura Bush,’ is a reseeding annual petunia that is available in a limited range of flower colors. Because somaclonal variation in a number of morphological features has been reported previously in petunia and other members of the Solanaceae, a project was undertaken to determine whether tissue culture could be used to isolate flower color variants of ‘Laura Bush’ petunia with ornamental potential. Explants were excised from leaves of a single greenhouse-grown plant and cultured on Murashige and

Skoog medium containing 4.4  $\mu$ M BA using standard in vitro culture procedures. Microcuttings were harvested from shoot proliferating cultures after 8 weeks, rooted under non-sterile conditions in plastic containers containing moistened Redi-earth, acclimated and then grown under standard horticultural practice in the greenhouse. A total of 880 plants were evaluated as they came into bloom. The rate of somaclonal variation estimated by visual scoring was 15%. Variants were grouped into several broad categories including leaf variegation, abnormally large leaves and flowers, severe stunting, fasciated stems, bilateral asymmetry of leaves, midvein abnormality, missing corolla segments, and abnormally small flowers. Large-leafed/large-flowered plants were the most prominent off-type (13%) with variegation occurring next most frequently (3%) and the remaining types occurring in less than 1% of the plants observed. Three types of variegated-leaf periclinal chimera were stabilized and are being cloned. No variation in flower color was observed.

11:15–11:30 am

### **Photosynthetic, Antioxidant, and Anticancer Properties of Soybean under Drought and Mechanical Wounding**

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Drought and tissue wounding are common environmental stresses that limit crop productivity. We hypothesized that drought and leaf wounding would change photosynthetic variables, and such changes would be correlated to concentrations of phytoalexin flavonoids of importance to human health, in soybean. Thus, a greenhouse study was undertaken to determine the effects of drought and mechanical wounding on leaf gas exchange, photosystem II efficiency, total antioxidant capacity and the yields of anticancer kaempferols and glyceollins in soybean cultivar, IA 2032. Drought and wounding were imposed twice, each time by withholding water for 3 days, and making 10 holes on the left leaflet of all leaves of the fourth branch from bottom with a hole puncher, respectively, during pod filling. Droughted plants were allowed to recover by watering between treatments for four days. By the end of second treatment cycles, photosynthesis

dropped by 98% accompanied by 6% and 90% decreases in photosystem II efficiency and stomatal conductance, respectively, in droughted plants compared with control. Drought decreased chlorophyll content by 28% with no effect on carotenoid levels but increased total antioxidant capacity by 88%. In wounded plants, photosynthesis increased by 25% with 8% and 79% increases in photosystem II efficiency and stomatal conductance, respectively, compared with control. Wounding had no effect on chlorophylls, carotenoids and antioxidant capacity. During recovery, 4 days after the second drought and 7 days after second wounding, photosynthesis was still 44% less in droughted plants accompanied by 17% and 53% decreases in photosystem II efficiency and stomatal conductance. Chlorophyll and carotenoid contents were 45% and 44% less, but total antioxidant capacity was still 41% greater in droughted plants. Wounded plants had the same photosynthesis, photosystem II efficiency and antioxidant capacity, but 31% greater stomatal conductance with 24% and 29% less chlorophylls and carotenoids, respectively, compared with control. Drought stress but not wounding enhanced total antioxidant capacity in soybean leaves. Preliminary results suggest that concentrations of four leaf kaempferols were reduced by stress, especially wounding. Drought-elicited antioxidant capacity was not due to chlorophylls, carotenoids or kaempferols in soy leaves. Changes in photosynthetic variables under stress did not appear to be correlated with leaf kaempferol levels. Leaves had no detectable levels of glyceollins while stems, seeds and roots are currently analyzed.

*Specified Source(s) of Funding:* USDA-Tulane-Xavier Cooperative Agreement

11:30–11:45 am

### **Syntenic Analysis of Cucurbit Cultivar Complex using Microsatellite Markers**

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The Cucurbitaceae family is a monophyletic clade because of its morphological and biochemical distinctness and represents some of economically important species, particularly those

with edible and medicinal fruits (Batas and Robinson, 1995; Whitaker and Bemis, 1976). Cucurbitaceae is known to have 90 genera and 700 species, of which there are several domesticated species. Cucurbit species include a variety of high value crops that play important role both in local diets and as export crops in the US. The cultivated watermelon belongs to *Citrus lanatus* var. *lanatus*, which is considered as a descendent of the species *C. colocynthis* (Navot and Zamir, 1987; Levi et al. 2000). Melons (*Cucumis melo* L.) are a diverse group. Summer squash is *Cucurbita pepo*, but winter squash may be *C. pepo* (e.g. 'Acorn') or *C. moschata* ('Butternut'). Microsatellites or single sequence repeats (SSRs) are short repetitive nucleotide motifs found throughout the genome of all eukaryotes. Microsatellite markers are co-dominant, multi-allelic and high polymorphic. Current research is focused to identify heterologous fruit related microsatellites that can be used to identify common fruit traits at molecular level across the Cucurbitaceae family. DNA was extracted from leaf tissues using the method described in the QIAGEN DNeasy Plant Mini Kit. Fruit specific microsatellite sequences were obtained from the web site of International Cucurbit Genomics Initiative (<http://www.icugi.org>). Primers were designed using the software PRIMER 3.0 (<http://frodo.wi.mit.edu>). PCR conditions for SSRs were used as per Reddy et al., (2001) and gel electrophoresis was carried out using SFR high-resolution agarose ([www.amresco-inc.com](http://www.amresco-inc.com)). Genetic similarities based on Jaccard's coefficients (Jaccard 1908) were calculated using the SIMQUAL program of the Numerical Taxonomy Multivariate Analysis System (NTSYS-pc) Version 2.0 software package (Rohlf 1997). The resulting genetic diversity indices were used to generate a tree using the Neighbor Joining method (Saitou and Nei 1987). Principal component analysis (PCA) based on the genetic similarity matrices were performed using DCENTER and EIGEN algorithms of the NTSYS-pc software package. We identified 176 fruit related EST specific SSRs developed from melon to amplify 750 different alleles across the 12 taxa that belong to the sub-family Cucurbitae (squash and pumpkin) and the subfamily Benincaseae (watermelon, melon, bottler gourd and bitter gourd). A phylogenetic tree and PCA clearly resolved various taxa according to their classical taxonomic relationships. The microsatellite markers that are characterized as heterologous can be of immense use for cucurbit breeding community for use in marker assisted selections and the other genetic/syntenic studies.

*Specified Source(s) of Funding:* USDA-CSREES

11:45–12:00 pm

### **Effect of Packaging Design and Materials on the Aroma Profile of 'Chester' Blackberries under Retail Conditions**

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Aroma, a complex chemical pattern where compounds such as alcohols, esters, aldehydes, ketones, acids and others are involved, plays a key role in the appeal of fresh produce. Extrinsic factors such as packaging can significantly affect this quality parameter. In this study, the effects of four different packaging systems on the evolution of the aroma profile of 'Chester' blackberries during storage at low temperature are compared. 'Chester' blackberries were packaged in packages differing in design: open and enclosed, and in material: bio-based and petroleum-based, and then were stored at 3 °C for 3 weeks. The main aroma volatile compounds of 'Chester' blackberries were identified by gas chromatography-mass spectrometry (GC-MS) and solid-phase microextraction (SPME) fiber as ethanol, ethyl acetate, hexanal, trans-2-hexenal, 2-heptanone, ethyl hepanoate, 2-ethyl-1-hexanol, D-limonene, 1-hexanol, and nonanal. The quantitative analyses of these compounds during storage were performed by gas chromatography equipped with a flame ionization detector (GC-FID) and SPME fiber. In addition, oxygen and carbon dioxide permeabilities of the packages were measured using an 8100 Oxygen analyzer, and a Permatran™ C 4/41 analyzer in order to determine the permselectivity of the different materials. The levels of most aroma compounds decreased during storage, with the most pronounced decreases observed for ethanol, hexanal, trans-2-hexenal, 1-hexanol, 2-heptanone, and ethyl hepanoate. This trend was not observed for ethanol and 2-heptanone in the open design package. In addition, this package consistently showed higher quantities of each volatile, which can be attributed to a higher moisture loss of the berries in the open system and therefore a higher concentration of the aroma compounds. Comparing fruit from packages of the same material but different design, revealed significant differences in volatile concentrations during the first week of storage, after which these differences became insignificant. Fruit from packages of different material but same design showed similar trends in volatile compound levels. This can be attributed to the same permselectivity calculated for the bio-based and petroleum-based material. No effect of design or material was observed on D-limonene, 2-ethyl-1-hexanol, and nonanal

*Specified Source(s) of Funding:* Private

## Tuesday, August 3, 2010 Springs K & L Oral Session 18: Ornamentals/ Landscape & Turf 2

10:15–10:30 am

### Organic Amendments and Sulfur in Combination Reduce Soil pH

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Crop plants such as blueberry and landscape species such as rhododendron prefer relatively low soil pH; they often fail to thrive in alkaline soils found in California. Sulfur, added to reduce soil pH, is slow to mineralize and dependent on soil microbial processes. A single application of sulfur (5600 kg/ha) resulted in a 5-fold increase in extractable sulfate after 2 weeks; sulfate content roughly doubled at each subsequent sampling during the first year and was 760 ppm after 2 years. Tall fescue (*Festuca arundinaceae*) was seeded 4 months after sulfur was applied. Sulfate content in plots with fescue was 61% lower than in plots without fescue after 1 year and 85% lower after 2 years, indicating significant uptake by the grass cover. Both sulfur and fescue increased organic matter content by 0.1% during 2.5 years. pH was reduced from 7.8 to 7.0 and 6.3 after 1 and 2 years, respectively, in plots with sulfur. pH was reduced to 6.7 by application of commercial coffee grounds (25% by volume in 1-m<sup>2</sup> plots) after 1 month; after 2.5 years, pH was 7.2, the lowest of any organic amendment. Application of culled lemon fruit ground in a wood chipper caused an immediate soil pH reduction to below pH 5; pH ranging from 6.6 to 7.5 persisted for 2 months after application. Peat moss and *Pinus canariensis* (canary island pine) needles reduced pH to 6.7 and 7.4, respectively, for about 2 weeks, while *Quercus agrifolia* (coast live oak) leaves and municipal yardwaste had no effect. The combination of sulfur with each amendment, however, resulted in a synergistic pH reduction measurable after 1 year. pH for coffee, lemon, oak, pine and yardwaste treatments ranged from 5.2 to 5.5 with sulfur compared to 7.5 to 7.8 without sulfur. Peat moss had the largest range in soil pH after 2 years: pH 5.1 with sulfur compared to 7.6 without. Organic matter content in coffee plots ranged from 4.5% at the start to 2.4% after 2 years, the highest of any amendment. Organic matter content after application of peat and culled lemons averaged 2.9% and 2.5%, respectively, compared to 1.5% for unamended soil. Although increased organic matter content and reduction in soil pH was measured using sulfur and some organic amendments alone, coffee, peat, and culled lemons in combination with sulfur achieved the greatest and most sustained pH reduction.

10:30–10:45 am

### Effect of Leaf Removal and Tie-up on Large, Mature Date Palms Transplanted in Extremely Hot Conditions

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Palms are increasingly important components of subtropical and warm temperate landscapes in Florida, the Gulf Coast, and the southwestern U.S. Because of their unique root and trunk morphology, large specimen palms can be transplanted with a relatively small root ball, creating an instant, mature landscape. Common and standard industry practices when transplanting palms is to reduce leaf area by removing some leaves and temporarily to tie up the remaining leaves. Recent work, though, has shown that in most cases these practices are unnecessary. However, some industry workers still contended that leaf removal and tie up were necessary when transplanting palms in extremely hot conditions (> 35 °C). To investigate this contention, we evaluated the response of date palms (*Phoenix dactylifera* L. 'Halawy') to leaf removal and tie up when transplanted in the heat of mid summer. Preliminary results show that six months after transplanting in temperatures of 46 °C there was a strong trend for leaf removal and tie up to improve survival. Thus, these practices may have merit when transplanting some species of palms in extremely hot conditions.

10:45–11:00 am

### Effect of Sand Backfill on Transplanted Palms

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Palms are increasingly important components of subtropical and warm temperate landscapes in Florida, the Gulf Coast, and the southwestern U. S. Because of their unique root and trunk morphology, large specimen palms can be transplanted with a relatively small root ball, creating an instant, mature landscape. A common and standard industry practice, especially in the southwestern U. S., is to use builder's or washed plaster sand as the sole backfill medium when transplanting palms although there is no research-based information or recommendations supporting this practice. We evaluated the responses of three species of transplanted landscape palms, king palm (*Archontophoenix cunninghamiana*), queen palm (*Syagrus romanzoffiana*), and windmill palm (*Trachycarpus fortunei*), to sand or native site soil used as the backfill medium. Twelve months after transplanting there was a strong trend for the sand backfill to enhance color, reduce wilt, and increase leaf production with king and windmill palms. All king and windmill palms with the sand backfill survived while 80% of the king and 20% of the windmill palms

with the soil backfill died. Queen palms were unaffected by the backfill medium. Thus, sand backfill may improve transplant success with some species of palms.

11:00–11:15 am

### Effect of Exogenous Fructose on Creeping Bentgrass Heat Tolerance

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Golf course putting greens are some of the most intensively managed areas of turf and are subjected to high stress through play and management practices. Creeping bentgrass (*Agrostis stolonifera*) is a popular choice amongst golf courses due to its high putting quality. However, in warmer climates, detrimental heat stress occurs, resulting in lowered photosynthetic efficiency and inadequate sugar production. An exogenous application of sugar in the form of fructose could potentially compensate for the lack of sugar being produced during heat stress. The objectives of this research were to determine if exogenous applications of fructose: 1) were taken up by the plant and, 2) produce measured physiological responses during heat stressed times. Field studies were conducted testing 2 types of fructose sources, a high fructose corn syrup and a pure fructose, ranging from 0.5%–8.0% mass/volume of sugar to water with a combination of surfactant. Field data collected included visual ratings, normalized difference vegetative index (NDVI) readings, and root measurement. Field results showed some phytotoxicity with high rates of fructose, while lower rates showed no visible damage compared to an untreated control. Low rates of surfactant resulted in very little phytotoxicity, while high surfactant rates showed damage, even at low fructose levels. Fructose had no positive effect on rooting, visual ratings, or NDVI readings. A surfactant study was then designed to measure the effect of various surfactants on fructose uptake. This study revealed that as hydrophilic to lipophilic balance increased, uptake of fructose increased. Surfactant concentrations were beneficial at 0.1 and 0.25% v/v, but higher rates reduced fructose uptake. Studies examining the uptake of radiolabeled fructose will also be discussed.

11:15–11:30 am

### Moisture Content of Extensive Green Roof Growing Media and Growth Response of 15 Plant Species during Dry Down

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Success of an extensive green roof is primarily dependent on plant species ability to survive the low moisture content of the growing media. Due to the well-drained nature of the growing media, plants adaptable to dry, porous soils are primarily used in extensive green roof applications. Although *Sedum* species have dominated the plant palette for extensive green roofs, there is growing interest in expanding the plant list for extensive green roof systems. In order to effectively select suitable plants, species need to be evaluated in terms of their response to gradual and prolonged dry down of the growing media. A study to determine the relative rates of dry down for 15 species was conducted in greenhouse and outdoor trials. During dry downs that extended over 5 months, succulent and herbaceous species dried down at different rates. Although, not all succulent or herbaceous plants had consistent moisture contents during the initial 18 days of dry down. Despite differences in dry down, the succulent species, as a group, maintained viable foliage for over 5 times longer than the herbaceous species. The revival rates of the succulent species were nearly double those of the herbaceous species. Therefore, not only are succulent species more likely to be longer-lived during periods of drought, but these species are more likely to resume growth soon after water is made available. Based on these results, irrigation frequency is recommended for succulent species at a maximum of 28-day intervals and herbaceous species at a maximum of 14 day intervals.

11:30–11:45 am

### Two Methods of Quantifying Plant Cover for Evaluating Species for Extensive Green Roof Culture

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This research examined plant area covered for six plant species on an existing modular extensive green roof in semi-arid Colorado. Species evaluated were *Antennaria parvifolia* Nutt., *Bouteloua gracilis* (Kunth) Lag., *Delosperma cooperi* (Hook. f.) L. Bol., *Eriogonum umbellatum* Torr. aureum 'Psdowns', *Opuntia fragilis* Nutt. and *Sedum lanceolatum* Torr. Most reported methods for measuring plant area covered (plant cover) are subjective and not based on quantitative measurements. This study compared digital image analysis data (DIA) to manually collected converted two-dimensional data (C2D) for plants grown on an extensive green roof. For each plant in the study, digital images and manual two-dimensional measurements were taken on four dates (at 6-week intervals) in 2008 and on four dates (at 6-week intervals) in 2009. Using SigmaScan Pro 5.0 image analysis software, DIA was performed on these images. Additionally, comparisons between DIA data and final biomass, and C2D and final biomass, were performed. Plant cover increased for all six species during the 2008 growing season. However, *E. umbellatum aureum* 'Psdowns' had a low overwintering rate (12.5%) and was removed from analysis in 2009. In the spring of 2009, four of the five remaining species exhibited decreased plant cover due to winter dieback; the one exception was *O. fragilis*. In terms of plant cover, both quantification methods (C2D and DIA) revealed that *B. gracilis* and *D. cooperi* outperformed *A. parvifolia*, *O. fragilis*, and *S. lanceolatum*. Thus, five of the six species evaluated in this study are appropriate for use in extensive green roof applications. High levels of correlation were found between the DIA and C2D data sets ( $r = 0.77$ ) averaged over the five species on all eight data collection dates. The groundcover species (*A. parvifolia*, *D. cooperi*, and *S. lanceolatum*) had a higher correlation on average ( $r = 0.83$ ) than the upright (*B. gracilis*,  $r = 0.70$ ) and decumbent (*O. fragilis*,  $r = 0.65$ ) species. Additionally, DIA and final biomass correlations showed parallel trends with groundcovers averaging  $r = 0.83$ , upright  $r = 0.64$  and decumbent  $r = 0.41$ . Therefore, using DIA to evaluate plant cover and biomass accumulation is especially appropriate for groundcover species.

*Specified Source(s) of Funding:* Environmental Protection Agency (EPA)

11:45–12:00 pm

### Mapping Land Cover in Urban Residential Landscapes using Fine Resolution Imagery and Object-oriented Classification

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A knowledge of different types of land cover in urban residential landscapes is important for building social and economic city-wide policies including landscape ordinances and water conservation programs. Urban landscapes are typically heterogeneous, so classification of land cover in these areas requires fine resolution imagery in order to capture the level of detail required for effective decision-making. The main objective of our research was to characterize land cover proportions by zip code in Albuquerque, New Mexico. To achieve this objective, we classified a random selection of residential land parcels using object-oriented classification and fine spatial resolution photographic imagery. Vector data representing land parcels within the city limits of Albuquerque, zip codes, and land-use were used to create an integrated Geographic Information System (GIS) database. The database was stratified based on 16 zip codes, then 30 parcels were randomly selected from each zip code. Orthorectified, true color aerial photographs acquired in 2008 with 0.15 m (0.5 ft) resolution were used to identify irrigated areas (trees, shrubs and grass), swimming pools and non-irrigated areas using the object-oriented classification module embedded in ENVIEX 4.7.1 software. Imagery was first segmented to produce meaningful image objects. These objects were then classified using a nearest neighbor algorithm. The variables used in this classification were: spatial, textural and spectral attributes. Then, we assessed classification accuracy and calculated landscape feature areas. Accuracy assessment was calculated using confusion matrices. Results showed that user's and producer's accuracy for different classes in the six zip codes ranged from 73% to 100%. Overall classification accuracy ranged from 80% to 90%. Most zip codes had a common landscape with 75% trees and 25% shrubs and turf. One zip code had 50% trees, 40% grass and 10% shrubs. About half of the parcels in three zip codes (87104, 87106, and 87110) had 40% of the parcel irrigated, while 80% of parcels in the other zip codes had irrigated areas of about 20%. Knowledge of these land cover proportions will provide useful guidance for water conservation and residential landscapes policies.

*Specified Source(s) of Funding:* NOAA

## Tuesday, August 3, 2010 Springs A & B Oral Session 19: Crop Physiology: Floriculture

10:45–11:00 am

### Quantification of Carbon Assimilation by Indoor Plants in Simulated and In Situ Environments

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Carbon dioxide assimilation rates and total carbon fixed in plant tissue were assessed in a variety of species commonly grown in interior environments. Quantitative data was obtained under 1) controlled conditions simulating a typical range of irradiance levels encountered indoors (10, 20, or 30  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ); and 2) in situ conditions in interiorscapes. Under the former, plants were grown for 10 weeks and their photosynthetic rates were assessed before and after this period. Species varied in their daily carbon gain (net amount of carbon fixed by each plant in a 24-hour period) and their carbon use efficiency (fraction of carbon fixed in gross photosynthesis and incorporated into biomass), with *Spathiphyllum* and *Aglaonema*, exhibiting higher values compared to *Scindapsus*, *Philodendron*, *Sanseveria*, *Ctenanthe*, or *Ficus benjamina*. Carbon content was lower in herbaceous species (e.g. *Scindapsus aureus*, 38% of dry mass) compared to woody ones (e.g. *Ficus benjamina*, 43%). A positive relationship between duration and irradiance level of the acclimatization period was found for all species, which in turn impacted photosynthetic rates in subsequent interior environment. A positive relationship between plant age and amount of carbon fixed was also found. All species exhibited positive carbon gain under simulated irradiance levels, although some species (e.g., *Spathiphyllum*, had significantly higher values (up to 3.5 g of carbon dioxide per week). In situ, plants exhibited varying photosynthetic rates and carbon gains, largely dependent on irradiance level. Predictably, a positive correlation was found between irradiance level and amount of carbon incorporated into biomass. In general, a large plant and/or species with higher amount of woody tissue in their above- or belowground organs (e.g., 14-ft arboreal plant), removed more carbon over time, compared to a small and/or herbaceous species. This study is the first to provide quantitative data of carbon assimilation under interiorscape environments. Data from this as well as past research support the view that under typical interiorscape irradiance levels, carbon assimilation in plant tissue represents a carbon gain. Interiorscape plants have been documented to remove volatile organic compounds (VOCs) and this aspect has been used by the industry to promote the health benefits of indoor plants. Carbon dioxide assimilation provides corollary information to the VOC removal and a more complete assessment of plants' benefits to the indoor environment. While the impact of ambient  $\text{CO}_2$  removal may be modest, it represents a positive benefit that has the potential to further enhance the purchase and use of indoor plants.

*Specified Source(s) of Funding:* National Foliage Foundation

11:00–11:15 am

### Determining Optimum EC Levels and Elements for Extended Vase Life of Cut *Rosa* 'Freedom', 'Charlotte', and 'Classy'

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Cut *Rosa* L. 'Freedom', 'Charlotte', and 'Classy' stems were subjected to solutions of various EC levels created by adding NaCl, Na<sub>2</sub>SO<sub>4</sub>, or CaCl<sub>2</sub> to either distilled water or distilled water plus a commercial floral preservative. When 'Freedom' stems were subjected to 0, 0.25, 0.50, 0.75, 1.0, 2.0, 2.5, 3.0, 3.5, or 4.0 dS·m<sup>-1</sup> from NaCl added to distilled water, the longest vase life occurred with 0.5 dS·m<sup>-1</sup>. The addition of floral preservatives to the vase solution not only extended the vase life, but also overcame negative effects of high EC, with maximum vase life occurring at 1.0 dS·m<sup>-1</sup>. Furthermore, stems in preservative experienced significantly less bent neck and opened more fully than those in water. Stems placed in water with a preservative also experience more bluing, brown petals, rot, and loss of pigment, which was probably due to increased vase life. As with NaCl, Na<sub>2</sub>SO<sub>4</sub>, and CaCl<sub>2</sub> produced a similarly long vase life at 1.0 dS·m<sup>-1</sup> and increasing EC decreased vase life. As EC increased, regardless of salt type, water uptake increased up to a maximum of 1.0 dS·m<sup>-1</sup>, then decreased. Maximum vase life occurred at 1.0 dS·m<sup>-1</sup> for cut 'Charlotte' stems, but at 0.5 dS·m<sup>-1</sup> for 'Classy'. When cut 'Freedom' stems were subjected to distilled water solutions containing 0.1, 1, 10 or 100 mg·L<sup>-1</sup> B, Cu, Fe, K, Mg, Mn, or Zn, none of the solutions increased vase life and only 10 or 100 mg·L<sup>-1</sup> B and 100 mg·L<sup>-1</sup> Cu reduced vase life. The addition of NaCl to reach 0.75 dS·m<sup>-1</sup> for all solutions increased vase life. In solutions where both initial pH and EC varied, initial pH accounted for 30% to 54% of variation in vase life (average 44%) and initial EC accounted for 18% to 48% of variation (average 36%).

*Specified Source(s) of Funding:* Dole Foods

11:15–11:30 am

### Effects of Sodium Chloride on Growth and Morphology of Two Petunia Cultivars

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Saline irrigation water may arise from seawater incursion of aquifers, use of reclaimed municipal water, or in greenhouse/nursery water capture and reuse systems. Many floriculture species are sensitive to salt accumulation in the root zone, showing severe symptoms when exposed to high soluble salts such as leaf marginal necrosis and ultimately reduced plant growth. However, the quantitative effects of increasing NaCl stress on growth and morphology have not been reported for most floriculture species. The objective of this project was to determine the effect of NaCl salinity on growth and morphology of *Petunia ×hybrida* [Vilm]. 'Bravo White' (BW) and 'Mitchell Diploid' (MD). Plants were grown hydroponically, so that a stable root-zone salt treatment could be maintained through frequent replenishment of the nutrient solution. Six week old seedlings were established in 4 L hydroponic containers with a modified Hoagland's solution for 2 weeks prior to receiving

NaCl treatments. Plants were exposed to 0, 20, 40, 60 and 80 mM NaCl amended to the nutrient solution for the 4 week treatment period resulting in average electrical conductivity of 1.64, 4.69, 6.37, 8.07, and 9.45 dS/m, respectively. Nutrient solution in each bucket was replaced weekly. Both cultivars responded similarly to salt treatment, as ANOVA found no cultivar by salt treatment interaction for any of the measured parameters. Leaf Chlorophyll index (SPAD units) of BW, was reduced from 33 to 26 as NaCl increased from 0 to 80 mM, whereas in MD chlorophyll index was reduced from 41 to 33 SPAD units. Leaf surface area (LSA) was reduced from 7555 to 2744 cm<sup>2</sup> in BW, and from 7385 to 1826 cm<sup>2</sup> as NaCl concentration increased. Fresh matter of both cultivars was reduced from 63–67% and dry matter was reduced by 62–65% as NaCl concentration increased from 0 to 80mM. In general, morphological parameters (height and width) were less affected by salt than growth parameters (LSA, FW/DW). For example, plant width and height of BW was reduced by 34% and 22% respectively as NaCl increased to 80 mM. For both cultivars a significant difference in growth/morphological parameters was not observed as NaCl increased from 0 to 20 mM. However, quantitative models suggest a moderate reduction in growth at 20 mM NaCl. BW and MD can be grown hydroponically with slightly saline solution (20 mM NaCl) to produce visually acceptable plants. More research is needed to determine salt effects in peat-based substrates typical of greenhouse production.

*Specified Source(s) of Funding:* USDA Hatch, Post-Schenkel Endowment

11:30–11:45 am

### Long-term Low-concentration Ethylene Exposure Affects Growth, Flowering and Development of 28 Ornamental Taxa

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Five plants each of 28 ornamental taxa were grown in equivalent greenhouse environments for 2 weeks after transplanting. Ethylene was released daily for 6 more weeks in each house from 4 PM to 9 AM to achieve the treatment concentration of 0, 0.01, or 0.05 μL·L<sup>-1</sup> ethylene. Growth and development responses were measured by number of abscised organs, flower counts, plant height, diameter, fresh and dry weight. Increased growth of *Ocimum basilicum* L., *Solenostemon scutellarioides* (L.) Codd, and *Dahlia* Cav. was positively correlated with ethylene concentration. *Cuphea hyssopifolia* Kunth, *Lobelia erinus* L., and *Osteospermum ecklonis* (DC.) Norl. grew larger at 0.01 μL·L<sup>-1</sup> ethylene than at either 0, or 0.05 μL·L<sup>-1</sup> ethylene. Increased growth was negatively correlated to ethylene concentration for *Gerbera jamesonii* Bolus ex Hook. f., *Capsicum annuum* L., *Solanum lycopersicum* L., and *Petunia integrifolia* (Hook.) Schinz & Thell. While ethylene inhibited lateral branch growth



of *Fuchsia hybrida* hort. ex Siebold & Voss, *Calibrachoa* Llave & Lex. and *Portulaca oleracea* L., it promoted the same for *Ocimum basilicum*, *Lobelia erinus* and *Cuphea hyssopifolia*. Flowering was variably inhibited by any ethylene amount for most taxa though some partially recovered from the effect over time. Where flowering did occur in ethylene's presence, flower size was reduced and flower senescence was more rapid compared to control. Interestingly,  $0.01 \mu\text{L}\cdot\text{L}^{-1}$  ethylene inhibited flowering of *Antirrhinum majus* L. yet  $0.05 \mu\text{L}\cdot\text{L}^{-1}$  did not. Clearly, a given ethylene concentration can be a growth inhibitor for some species while for others it encourages growth. Additionally, ethylene may encourage a specific response at one concentration while suppressing that same response at another concentration. These results lend support to the hypothesis that ethylene response, whether growth promotion or inhibition, is incorporated into a single concentration dependent biphasic response model.

*Specified Source(s) of Funding:* Gloeckner Foundation

11:45–12:00 pm

### **An Updated Production Protocol for Growing Containerized *Ranunculus asiaticus* from Its Dried Tuberos Roots**

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*Ranunculus asiaticus* is an ornamental geophyte produced commercially as a cut flower and flowering potted plant, with strong potential for use in landscape designs. Yet production has become limited due to a number of concerns when producing these plants from their dried tuberos roots. Unfortunately, information on containerized production of *R. asiaticus* is often limited and lacks consistency. Our research has investigated several factors affecting successful regrowth and plant quality of *R. asiaticus* dried "tubers," including hydration and fungicide application techniques, and has focused on formulating a unified production protocol for the tubers following storage.

*Specified Source(s) of Funding:* Fred C. Gloeckner and Post Schenkel Foundations. Also California Flowerbulb Co.

## **Tuesday, August 3, 2010 Springs A & B Oral Session 20: Ornamentals/ Landscape & Turf**

2:00–2:15 pm

### **Influence of Soil Texture, Precipitation Intensity, and Soil Moisture on Stormwater Runoff and Leachate**

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Soil texture, soil moisture, and precipitation intensity have the potential to influence stormwater runoff and leachate. To examine these relationships, eighteen lysimeters were constructed which contain six replications each of three sandy soil compositions representative of those found in newly constructed residential communities in central Florida. Three precipitation intensities, ranging from 6.2 to 18.7 mm in 15 min, were chosen to simulate local historical weather data. The relationships between precipitation rates, soil moisture, and soil texture as they influenced partitioning between stormwater runoff and leachate will be discussed.

2:15–2:30 pm

### **Estimating Water Needs of Urban Landscapes**

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Many water agencies and jurisdictions in urban areas of the western U.S. are using climate-based reference evapotranspiration (ET<sub>o</sub>) data to determine landscape water budgets and water prices. Nationally, the WaterSense program sponsored by the U.S. Environmental Protection Agency promotes ET<sub>o</sub>-based landscape water budgets as a means for certifying new homes as water efficient. Consequently, landscape architects, landscape management professionals, and the tools they use, such as software and smart irrigation control devices, are incorporating this approach to derive irrigation schedules. Formulae and algorithms used to produce these ET<sub>o</sub>-based water budgets and irrigation schedules require multiplying local ET<sub>o</sub> estimates by an adjustment factor, known as a crop coefficient (K<sub>c</sub>) or a plant factor (PF), that accounts for each particular plant's water need as a function of local climate. These numbers are usually expressed as a decimal less than 1.0 or a percentage less than 100%. However, reliable research-based data on landscape plant water needs in terms of K<sub>c</sub> or PF values is extremely limited. Few information sources offer any form of quantitative estimates of landscape plants' water requirements. Most of those that do, including the widely-referenced publication, "Water Use Classification of Landscape Species" (WUCOLS), are not based on scientific data. Using the PF or K<sub>c</sub> values available from these sources gives users a false sense of precision in the water budgets and schedules they calculate or that their smart controller develops. Fortunately, there have been some scientific field studies completed over the past several years that provide ET<sub>o</sub>-based water need estimates or ranges for selected groups of landscape plants and afford effective means to evaluate the reliability of WUCOLS and similar information sources. The newer field research data on landscape plant water needs, how it relates to WUCOLS values, and how it can be used to calculate accurate and meaningful irrigation budgets and schedules will be presented.

2:30–2:45 pm

**A Comprehensive Research Method to Investigate the Environmental Issues of Urban Landscapes—Water Use and Nitrogen Leaching of Urban Landscapes on Community Water Quantity and Quality**

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Water supply has been a challenge in the arid and semi-arid Intermountain West region. Landscape irrigation represents a major portion of potable water use in the region; therefore water conservation in landscapes has received much attention in recent years. The effect of landscape irrigation on groundwater supplies in this region has not been studied. Additionally, nitrogen leaching from turf areas to groundwater has been investigated in other locations in the United States, but few research efforts have focused on the Intermountain West region. In this project, a field drainage lysimeter experiment was conducted to compare the water requirements of different types of landscapes: traditional (high water use), intermediate (moderate water use), and native/adapted plant species of the Intermountain West (low water use). Soil moisture data were collected hourly and the quantity and quality of leachate from the lysimeters was monitored. Water consumption of each landscape type was obtained using a water balance equation. The Hydrus-1D model was applied to simulate water and nitrogen transport in turf, and to predict bottom water flux and N-leaching under the scenario of over watering and over fertilization in turf areas. A greenhouse column lysimeter experiment will also be conducted to confirm the simulation result of over watering and fertilizing conditions. Monitoring data from the field and greenhouse studies will be used in conjunction with model results to determine the effect of water use in landscapes on groundwater quantity and the potential effect of ground water being contaminated by leachate from urban landscapes.

2:45–3:00 pm

**Salinity Tolerance of *Sequoia sempervirens***

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To reserve potable water for appropriate beneficial uses, reclaimed water is provided for irrigation of parks, golf courses, and other public landscapes within the Santa Clara Valley Water District in California. Unfortunately, the use of this water to irrigate landscapes appears to have led to the decline or death of coast redwoods within those sites. Since the reclaimed water used to irrigate these landscapes was found to be particularly high in sodium and chloride, an experiment was designed and implemented to determine the tolerance of this species to  $\text{Na}^+$  and  $\text{Cl}^-$ . *S. sempervirens* ‘Aptos Blue’ is widely used in landscapes and is known to be sensitive to salinity in irrigation water. Selecting a cultivar may also reduce variability in the data collected. Trees were grown in containers in a greenhouse and irrigated with a nutrient solution having an electrical conductivity (EC) of 0.5 dS/m. This solution also served as the control treatment. Four salt types:  $\text{NaCl}$ ,  $\text{Na}_2\text{SO}_4$ ,  $\text{CaCl}_2$ , and an equimolar combination of  $\text{NaCl}$  and  $\text{CaCl}_2$ , were added to the 0.5 dS/m nutrient solution at concentrations yielding total ECs of 1.0, 3.0, 4.5, and 6.0 dS/m, to create 16 salinity treatments. Irrigation occurred once daily with excessive volumes of treatment solution so as to reduce effects of water deficit stress and salt accumulation. The experiment was carried out over a period of 16 months. Trunk diameter was measured every 2 weeks. At 1.0 dS/m, there were no differences in trunk diameter. However, increasing treatment concentration above 1.0 dS/m, despite salt type, caused an increasing reduction in trunk diameter change. Plots of  $\text{meq}(\text{Na} + \text{Ca})/\text{L}$  versus trunk diameter yielded the same linear regression results despite salt type. Tree height and width were also measured, but results from these data were less clear due to high variability. Tissue samples of the distal and proximal portions of leaves were also taken at about 4-month intervals and analyzed for Na and Cl. An extensive collection of digital branch and leaf images were produced to record the development of toxicity symptoms.

*Specified Source(s) of Funding:* Santa Clara Valley Water District; City of Palo Alto, CA; City of Mountain View, CA

**Tuesday, August 3, 2010 Springs K & L  
Oral Session 21: Growth Chambers  
& Controlled Environments:  
Greenhouse/High Tunnels**

2:00–2:15 pm

**Vigor Response of Greenhouse Bell Pepper due to Chlorine Dioxide Sanitized Irrigation Water**

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Recycling greenhouse irrigation water is becoming a popular practice due to water conservation efforts worldwide. However, water must be sanitized prior to recirculation to prevent contamination with plant pathogens. Chlorine dioxide ( $\text{ClO}_2$ ), a common disinfectant used to treat municipal water and postharvest dump tanks, has been proposed as a disinfectant for recirculated irrigation systems. Little research has been performed to determine if this chemical is appropriate to use for irrigation on greenhouse specialty crops. The objective of this study was to determine the effects of  $\text{ClO}_2$  on the vigor of bell pepper plants grown in two different soilless medias (perlite and pine bark). Plants were transplanted in the Univ of Florida Protected Agriculture Project Greenhouse in Nov. Chlorine dioxide was added to the irrigation solution 11 days after transplanting at concentrations of 0, 10, 20 and 40 ppm. Relatively high concentrations were used to estimate an upper threshold for pepper tolerance to  $\text{ClO}_2$ . The experiment was repeated in March with reduced concentrations of  $\text{ClO}_2$ : 0, 2.5, 5 and 10 ppm. Chlorine dioxide is used at concentrations between 0.5 to 2 ppm for drinking-water sanitation, and concentrations in this range are also more practical for greenhouse use. Pepper plant height was measured weekly for 6 weeks. Leaf area, fresh mass, and dry mass of plants was measured at the end of 6 weeks. Data were analyzed using SAS (v.9.2). There was no interaction between media and  $\text{ClO}_2$  concentration, therefore main effects are reported. For the concentrations examined, results indicate that increasing concentrations of  $\text{ClO}_2$  in the irrigation water is negatively associated with plant height, leaf area, fresh mass and dry mass. For all parameters, peppers produced in perlite were less vigorous than peppers produced in pine bark.

*Specified Source(s) of Funding:* Univ of Florida, Horticultural Sciences

2:15–2:30 pm

### **Effects of Different Support Media on Productivity of Some Lettuce and Salad Cultivars under Static Hydroponic System Culture**

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The research were conducted in a plastichouse in Antalya, Turkey. The aim of research was to compare the effects of different support media (sphagnum peat, cocopeat, rockwool) under a static hydroponic system on growth parameters such as length, width, weight, root length, root neck width, the number of leaf, root neck-shoot apex distance in lettuce and salad cultivars (Bohemia, Bijou, Bitez, Nestorix). In this study, the best growth results were obtained from Bitez group plants cultivated in sphagnum peat media with mean values of 26.06 cm for plant length, 543.93 g for plant weight and 62.11 for the number of leaf per plant. Lowest values were found in Nestorix group cultivated in cocopeat media with mean values of 13.56cm for plant length, 92.24g for plant weight and 23.33 for plant leaf number. The comparison of the organic and inorganic material based culture media showed that plants exhibit beter productivity results when cultured in organic material based media. Thus, sphagnum peat, an organic material based media is the most adequated to be used in hydroponic lettuce and salad culture.

*Specified Source(s) of Funding:* By myself+by my Univ

2:30–2:45 pm

### **Frost Protection for Early High Tunnel Tomatoes**

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By extending the growing season, high tunnels increase marketing opportunities, improve early cash flow, and increase marketable yields. High tunnels make it possible to plant and crop tomatoes one month earlier than field grown tomatoes in northern Utah. Greater protection from frost is needed if growers wish to plant more than 1 month earlier. Supplemental heating can be expensive when heating a large space, but low tunnels within high tunnels trap heat around tomato plants creating a smaller volume of air to keep warm. Sunbrite tomatoes were transplanted to four high tunnels on the Greenville Research farm in Logan, UT over three planting dates (17 Mar., 30 Mar., and 7 Apr.) in Spring 2009. Supplemental heat treatments included soil warming cables and 40-W incandescent lights (1 light for every 3 plants) which were evaluated alone and in combination for early season frost protection. Soil warming cables were buried 2.5 cm below soil and plastic mulch. All tomato plants were grown under 2-mil plastic low tunnels measuring 0.9 m wide and 1 m tall. Early yield was significantly higher in the plots heated with incandescent lights, while overall yield was similar between all heating treatments. The first 3 weeks of harvest were considered early. The 17 Mar. planting date had

significantly lower early season and overall yield, while yield was similar for later planting dates. The difference in yield between planting dates suggests that the heating treatments in this study did not provide sufficient cold protection to prevent injury. Information gathered in this study about costs, planting dates, and yields will be valuable to growers who want to utilize the benefits of growing tomatoes in high tunnels.

*Specified Source(s) of Funding:* Western SARE

2:45–3:00 pm

### **Evaluation of 11 Cultivars of Sprouting Broccoli (*Brassica oleracea* L.) for Potential as an Overwintering Crop for High Tunnels in New England**

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Eleven winter sprouting broccoli cultivars (*Brassica oleracea* L.) were sown and cultivated over 3 years in Durham, NH, from 2007 to 2010, for evaluation as a marketable spring crop. Varieties tested included 5 purple-sprouting, 5 white-sprouting cultivars, and one green annual broccoli ('DeCicco') as a control. Planted in the fall, this biennial vegetable can overwinter in New England conditions under a single layer of rowcover in unheated high tunnels. Experiments were conducted in a 9.1 m by 18.2 m (30 ft by 90 ft) unheated high tunnel of gothic design with 6-mil 4-year plastic, manual roll-up sides, and automatic ventilation fans. Temperature was recorded using HOBO U12 dataloggers to monitor ambient air temperatures outdoors, within tunnels, and within tunnels under a single layer of rowcover. The experimental design was split plot with 4 replications and experimental units of 7 plants. Plants were seeded in mid-August and were transplanted 4 weeks later on 45-cm-wide beds in a staggered double row with 23 cm between rows and 38 cm between plants within a row. All cultivars were evaluated for combined yield of marketable apical and lateral shoots and for winter damage. Marketable shoots were harvested during the months of March and April, and yields ranged from 0.6 to 1.4 kg·m<sup>-2</sup>. While statistically significant differences were detected between the highest and lowest yielding cultivars each year, the yields of most varieties were similar. As a group, white-sprouting cultivars had higher yields than purple-sprouting cultivars (ANOVA-F-test,  $P < 0.01$ ). Many cultivars experienced winter damage when grown in high tunnels without supplemental rowcover. However, all cultivars grown under rowcover in the high tunnel survived extreme low temperatures of  $-17^{\circ}\text{C}$  ( $2^{\circ}\text{F}$ ) on 16 Jan. 2009, when outdoor temperatures dropped to  $-28^{\circ}\text{C}$  ( $-18^{\circ}\text{F}$ ). In conclusion, several winter sprouting broccoli cultivars have potential as a spring crop in cool climate protected culture.

3:00–3:15 pm

### **High Tunnels and Secondary Row Covers Both Significantly Alter Wintertime Air Temperatures and Growing Degree Day Accumulation in a Southern Trial**

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High tunnels are unheated greenhouse-like structures used for season extension, in which temperature is often controlled by opening and closing walls and doors. A study is under way at Crystal Springs, MS, testing the influence of 5.0 ft tall, 3 ft. wide over-the-row tunnels (secondary covers) within high tunnels on the tunnel microclimate and crop performance. We established tomato (*Lycopersicon lycopersicum* cv. Legend) and zinnia (*Zinnia elegans* cv. Benary's Giant Crimson) transplants into replicated plots in Fall 2009 in three high tunnels. Cover treatments within the tunnels included no cover (NNCOV); and four covering fabric treatments that could be pulled over or off of a frame built over the crop row. A fixed protocol based on actual and forecast outside and tunnel temperatures guided tunnel opening and closing, as well as placement and removal of the secondary covers. We recorded air temperatures inside (NCOV) and outside of the tunnels (OUT), and under each cover treatment (COVS) in triplicate in each crop. Injury from several light frost events was more evident on NCOV than COVS plots, but no treatment prevented all injury from severe events in early January. For this first year of study, we could not complete maturation of a tomato crop before three days in a row with temperatures falling below  $18^{\circ}\text{F}$  ruined it. Up to that point, at which we terminated the experiment, the presence of the tunnel influenced air temperature more than covers. Compared to OUT, NCOV lead to an average increase in minimum, maximum and average temperature of 6.2, 29.3, and  $9.3^{\circ}\text{F}$ , respectively. Compared to NCOV, COVS lead to an increase in minimum, maximum and average temperature of +1.0 to +2.4,  $-0.3$  to +0.2, and +0.9 to +2.4  $^{\circ}\text{F}$ , respectively, within the tunnels. Growing degree-day (GDD) accumulation inside the tunnels, at GDD, base  $40^{\circ}\text{F}$  was more than 200% by greater than OUT, more than 500% at GDD<sub>50</sub>. The GDD<sub>40</sub> NCOV averaged 5% lower, and the GDD<sub>50</sub> 15% lower than with COVS.

*Specified Source(s) of Funding:* USDS NRI Agricultural Prosperity for Small- and Medium Sized Farmers

3:15–3:30 pm

### Effects of Air Velocity on Muskmelon Plant Growth, Yield, and Fruit Quality in a Chinese Solar Greenhouse

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The effect of different air velocities (0.4, 1.0, and 2.2 m·s<sup>-1</sup>) on muskmelon (*Cucumis melo*) in a single span, lean-to greenhouse (or “solar greenhouse”) was analyzed. The air velocity treatment was applied using a polytube air guide attached to a mechanical fan from 8 AM (after rolling up heat insulating covering of the roof) to 11:30 AM and from 3 PM to 5 PM every day after fruit setting. No air velocity treatment was applied from 11:30 AM to 3 PM, during which the greenhouse was well ventilated for cooling. After 40 days of air velocity treatment, the plant growth, yield and the quality of fruit were significantly affected by air velocity. The results showed that the treatment of 1.0 m·s<sup>-1</sup> air velocity achieved the greatest increase in plant growth and yield among the three air velocity treatments: 21.7% more single leaf area, 63.1% more LAI, 120.3% higher stomatal conductance, 2 days earlier maturation, 24.4% more fruit yield, and 11.1% higher total sugar in fruit, respectively, than those in the control (without wind treatment). The total soluble solids of fruit at 0.4, 1.0, and 2.2 m·s<sup>-1</sup> air velocity were 5.8%, 12.6%, and 13.9%, respectively greater than those in the control. The protein concentrations of fruit at 0.4, 1.0, and 2.2 m·s<sup>-1</sup> increased by 2.9%, 2.7%, and 3.6%, respectively, compared to those in the control. The reduced sugar concentrations of fruit at 0.4, 1.0, and 2.2 m·s<sup>-1</sup> decreased by 3.2%, 7.2%, and 9.7% compared to those in the control, respectively. Fruit pulp thickness and vitamin C showed no significant effects by air velocity. In conclusion, the effect of different air velocity on muskmelon in the single span, lean-to greenhouse was significant and the optimal air velocity was 1.0 m·s<sup>-1</sup>.

3:30–3:45 pm

### High Tunnel Primocane Fruiting Raspberry Production in a Cold Region (USDA Zone 3b) of the Upper Midwest

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Northern Minnesota has short growing seasons (109 days at Grand Rapids, MN) that put most primocane fruiting raspberries at risk for freezing damage. High tunnels have the potential to extend the season by several weeks in the spring and fall which

could benefit fall bearing raspberries. The objective of this study was to compare productivity of fall bearing raspberry cultivars in high tunnels with that in the field under USDA Zone 3b conditions. Bear root plants of five cultivars of primocane fruiting raspberries (Autumn Bliss, Autumn Britten, Caroline, Joan J, and Polana) were planted in a 21 × 48 ft high tunnel and in the field at 2 × 5 ft spacing using a randomized complete-block design on 8 and 14 May 2008, respectively. A propane heater was used for frost protection in the high tunnel for both years of the study. In 2008, 154 lb of berries were harvested from the high tunnel and 0.5 lb total from the field planting. The field season was terminated on 8 Oct., while the high tunnel season ended on 6 Nov., 4 weeks after the field season. Previous year’s canes were removed to the ground on 12 Mar. 2009. In 2009, all cultivars except for Polana grew to a height of 6–6.5 ft. A two-layer trellis system was used in the high tunnel to keep the canes from falling over. Total of 379 lb of berries (equivalent of 16,000 lb/acre) were harvested 5 Aug.–2 Nov. in the high tunnel, compared with only 80 lb of berries harvested 12 Aug.–5 Oct. in the field. For the five cultivars tested, Polana was the earliest, followed by Autumn Bliss, Autumn Britten, Joan J, and then Caroline. Although Caroline was the latest of the five cultivars tested, it was the most productive. Autumn Bliss was the least productive, while Polana, Autumn Britten, and Joan J were intermediate. Soil and leaf nutrient analyses showed that all nutrients were within sufficient ranges. The major pest was spider mites in the high tunnel, and was controlled well with predatory mites in 2009. Winter 2008–09 was cold with outside air temperatures of –40°C in mid January, but all cultivars sprouted out well with minor or no winter damage in the high tunnel in 2009. In conclusion, by using high tunnels, primocane fruiting raspberries can be successfully grown and profitable in northern Minnesota.

*Specified Source(s) of Funding:* Northeast Minnesota Sustainable Development Partnership this research was conducted at NCROC Univ of Minnesota at Grand Rapids, MN

3:45–4:00 pm

### Microclimate Effects on Ohio-grown Baby Lettuce: Biomass Accumulation and Composition

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Pre-harvest factors can limit the efficiency and productivity of vegetable cropping systems. Moisture, light, and root and shoot zone temperature influence plant biology and its manifestation in key traits, including yield (biomass, nutritional) and resource use efficiency and when abiotic conditions are sub-optimal, overall cropping system performance declines. Microclimate modification can reduce the occurrence of sub-optimal conditions. In this study, we expose lettuce to four aerial and root zone temperature treatments in two settings during spring and fall in Wooster, OH and document biomass accumulation and tissue composition. Plots are located within 0.61 m × 2.44 m × 0.15 m raised beds filled with a four-component, soil-based organic medium containing mostly peat moss and compost. Half of all plots are situated outdoors while all other plots are located within a 9.1 m × 24.4 m × 4.6 m high tunnel covered with a single layer of 6-mil clear film. Half of all plots in each setting are covered with 0.8-mil, clear, vented, low-tunnel film and half of all plots are underlain by electric heating cables triggered by temperatures below 23 °C. The use of low tunnel film and cables provides the treatments uncovered-unheated, covered-unheated, uncovered-heated and covered-heated in each setting. Red-leaved romaine lettuce varieties (Outredgeous, Flagship) are direct-seeded (2700 seed/m<sup>2</sup>) in early October and late March, overhead-irrigated as needed and harvested multiple times over the next 28 d, concluding when plants meet 'baby leaf' market criteria. Light, relative humidity, soil and air temperature are monitored throughout the experiment which has been repeated twice (2 seasons/year × 2 year). Harvested tissue is frozen and laboratory measures of anthocyanin, chlorophyll, sugar and vitamin C content and total antioxidant capacity are taken. Root and shoot-zone conditions and variety have significantly affected leaf biomass and composition, typically in both seasons and settings. Leaf yield has been greater in low tunnel-covered and bottom-heated plots than in uncovered-unheated plots with effects most dramatic in the open field setting. Anthocyanin and chlorophyll levels and total antioxidant power have generally been highest in treatments displaying the lowest total yield, regardless of setting. The negative relationship between anthocyanin level and yield is particularly clear in open field plots. We take these data as further evidence of the potential to alter early-stage lettuce biomass accumulation and composition through root- and shoot-zone microclimate modification, particularly during fall and spring in the Midwest

*Specified Source(s) of Funding:* OSU/OARDC-OSUE

Tuesday, August 3, 2010

Springs A & B

## Oral Session 22: Floriculture 2

3:15–3:30 pm

### Dairy Manure Compost Effects on Soilless Substrate EC and Plant Nutrient Uptake

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The effects of mature dairy manure compost (DMC; EC=5.0 mS·cm<sup>-1</sup>; pH=7.7) on EC, pH and nutrient contribution in a peat moss-perlite substrate were evaluated. In six substrates, peat moss plus DMC (DMC at 5% to 30% as partial peat substitute) was held constant at 75% volume and perlite at 25% without limestone addition. Two additional control treatments of 75% sphagnum peat moss and 25% perlite were formulated with and without agricultural dolomitic limestone. Five rooted cuttings of pot chrysanthemum 'Kory' [*Dendranthema ×grandiflora* (Ramat.) Kitam] were transplanted into each 16.5-cm diameter (1.4 L) plastic pot. Just after watering the newly transplanted plants with deionized water, substrate EC and pH, measured in pour-through extracts, were higher with each incremental increase of 0 to 30% DMC without limestone. EC and pH values ranged from 0.16 to 1.43 mS·cm<sup>-1</sup> and 3.7 to 6.2, respectively. With the exception of the transplanting day, plants were fertilized at each irrigation with 17N–2.2P–14.1K neutral fertilizer at 250 mg·L<sup>-1</sup> N for 12 weeks. On each of seven dates over 77 days of production, the EC levels of the unaltered substrate solution obtained by Rhizon samplers increased with increasing DMC rate. These EC levels of all substrates remained below the maximum general crop recommendation of 4.6 mS·cm<sup>-1</sup> for unaltered substrate solution except in the 25% and 30% DMC substrates at days 56 and 77. Analysis of recently matured leaves at days 35 and 84 indicated that additions of DMC, compared to the control with limestone, resulted in higher concentrations of K, S, Fe, Mn, Zn, and Cu, but lower concentrations of N, P, B, Mo, and Na. When compared to the unlimed control, uptake was moderately higher for Ca at 35 and 84 days in the 10% to 20% DMC treatments and for Mg at 84 days in the 10% DMC treatment. At higher DMC levels, Ca and Mg declined to levels below the control. When compared to the control with limestone at day 84, Ca and Mg were lower in the DMC substrates, most likely due to the residual supply of these nutrients in the limestone. Maximum growth occurred in the 10% DMC substrate and declined at higher rates of DMC to the level in the control with limestone. Plant shoot dry weight in the 15 to 30% DMC substrates did not differ from the control with limestone.

*Specified Source(s) of Funding:* The North Carolina Agricultural Research Service and the USDA, ARS

3:30–3:45 pm

### Silicon Supplementation and Regulated Deficit Irrigation Improve Poinsettia Quality and Postharvest Performance

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The effect of silicon on improving quality of container plants grown in soilless substrates is an area of active study. Improved stress tolerance, mechanical strength and disease resistance have been reported for several species, as well as changes in plant architecture and inflorescence size. To investigate possible beneficial effects of substrate applied Si in poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzsch) production; plants of 'Peterstar Red' and 'Prestige Red' poinsettias were grown under appropriate greenhouse conditions. The treatment design was a factorial arrangement of two Si concentrations, 0 and 56 mg·L<sup>-1</sup>, and three irrigation regimes, 100%, 80%, and 60% regulated deficit irrigation (RDI). Regulated deficit volumes were established gravimetrically using several well watered (100%) reference plants. Plants were evaluated for a variety of factors during production and postharvest storage. We observed significant main effects of Si and RDI in postharvest water stress tolerance, as measured by degree of wilt. Leaf wilt angle was reduced 40% in Si-amended plants and 30% in RDI (60% and 80%) plants after 15 days of simulated postharvest storage without water. Si amended plants exhibited improved recovery from severe wilting. RDI (60% and 80%) reduced overall height of plants by 5 to 10% and bract area 34 to 36%. However, Si supplementation offset some reduction in bract size in the 60% RDI plants, yet decreased bract size in the 80 and 100% RDI plants. Mechanical strength was increased by Si supplementation resulting in significantly reduced breakage and increased branch strength. By using a drop test of increasing 10 cm heights, we found that, across all RDI treatments Si supplementation reduced breakage 33 to 50%. The height at which the first broken branch occurred was 20% greater in Si amended plants compared to unamended plants. Bract edge burn (BEB), which is associated with disrupted water relations and Ca nutrition, was reduced 53% to 84% by Si amendment in 100% RDI plants, yet Si had no effect on BEB in 80% RDI plants and increased BEB in 60% RDI 'Peterstar Red' plants. These results support the use of RDI and Si in poinsettia production programs as methods of improving overall crop quality and in particular postharvest quality.

*Specified Source(s) of Funding:* New York Farm Viability Institute. USDA Hatch Program. Post Schenkel Endowment.

3:45–4:00 pm

### Controlling Water Content and Electrical Conductivity in Soilless Substrates using In Situ Sensors

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Efficient use of water and fertilizer is not only important for more sustainable production of greenhouse crops, but can have financial benefits as well. We have shown previously that irrigation can be controlled using soil moisture sensors and now are trying to control both irrigation and fertilizer applications using a sensor that can measure both substrate water content and bulk electrical conductivity or EC (5TE sensors, Decagon, Pullman WA). We grew ornamental cabbages (*Brassica oleracea*) in 15 cm-pots. A datalogger connected to 5TE sensors measured and recorded substrate water content and bulk EC in 16 pots. Pore water EC was calculated using the Hilhorst model, and plants were irrigated or fertigated based on water content and calculated pore water EC. The datalogger was programmed to maintain the substrate water content at 0.25, 0.30, 0.35, or 0.40 m<sup>3</sup>/m<sup>3</sup> and the pore water EC at 1, 2, 3, or 4 dS/m in a factorial arrangement. Control of substrate water content was good, generally within 0.03 m<sup>3</sup>/m<sup>3</sup> of the set point. Control of pore water EC was more difficult, and there were large fluctuations in pore water EC, especially during the first 20 days of the experiment. There are multiple reasons for these fluctuations: 1) pore water EC has to be calculated from substrate water content and bulk EC, and it is not clear how accurate the Hilhorst model is, 2) good contact between the small electrodes that serve as the EC sensor and the substrate is difficult to maintain, 3) The calculated pore water EC depends on the VWC of the substrate, resulting in rapid changes in pore water EC following an irrigation or fertigation event. In addition, as the substrate dries out following irrigation, the pore water EC increases because the solution becomes more concentrated as the amount of water decreases. We also noticed that fertilizer moves more slowly through the substrate than water and thus takes longer to reach the sensor. Both VWC and pore water EC set points affected the growth of the plants. Shoot dry weight decreased as the set point for pore water EC increased. Shoot dry weight also was reduced by low set points for VWC, while shoot dry weights were similar with set points of 0.35 and 0.4 m<sup>3</sup>/m<sup>3</sup>. Such effects of VWC on plant growth are consistent with earlier findings.

*Specified Source(s) of Funding:* USDA-NIFA-SCRI Award no. 2009-51181-05768, American Floral Endowment

4:00–4:15 pm

### Abcisic Acid Improves the Drought Stress Tolerance of Chrysanthemum and Aster

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Abcisic acid (ABA) is a plant hormone produced in roots in response to drought conditions. ABA is translocated to the leaves where it stimulates the closure of stomata, reducing transpiration and water loss. We investigated the effect of various ABA spray concentrations on drought stress tolerance of three cultivars each of finished potted chrysanthemum (*Chrysanthemum ×morifolium* Ramat.) and aster (*Aster novi-belgii* L.) Chrysanthemums were held in two postharvest greenhouse environments: one at 23/20 °C (9-h day/15-h night) and the other at 32/23 °C. Asters were held at 23/20 °C only. After all plants were well watered, 500, 1000, or 2000 mg·L<sup>-1</sup> of ABA were applied as a foliar spray at 0.2 L·m<sup>-2</sup> with the addition of a surfactant to improve ABA uptake into the leaves. Some plants were provided with a simulated shipping period (5 °C in darkness for 48 h) then returned to postharvest greenhouse conditions. Plants were subjectively scored at 0800 hr and again at 1600 hr based on their turgidity and overall appearance, where 3 = fully turgid and 0 = all leaves and flower buds had wilted. At 23/20 °C, the 500 and 1000 mg·L<sup>-1</sup> ABA applications to chrysanthemum increased the time to stage 2 (by 0.8 to 1.7 d) and stage 1 (by 1.7 to 3.1 d) for all three cultivars. ABA did not increase the time to wilting in any cultivar at 32/23 °C. The 500 and 1000 mg·L<sup>-1</sup> ABA applications to aster at 23/20 °C increased the number of days to stage 2 (by 0.7 to 1.5 d) and stage 0 (by 0.9 to 5.8 d) for all three cultivars studied. These results indicate that exogenous spray applications of ABA can be used to increase the postharvest drought stress tolerance of chrysanthemum and aster.

## Tuesday, August 3, 2010 Springs H & I Oral Session 23: Vegetable Crops Management: Cross-Commodity 1

4:15–4:30 pm

### Digital Image Analysis: A Substitute for Destructive Measures in Lettuce Production Research?

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Assessments of plant growth and biomass are ubiquitous in commercial and non-commercial crop production. Such assessments are followed by major decisions (e.g., harvest timing) that channel resources and influence commercial profit potential. In research, the materials and methods required for assessment affect other aspects of experimentation and, therefore, discovery. Destructive harvests are important because they influence treatment selection, replicate number and size, and the resources required for data collection. Destructive sampling also diminishes the opportunities for truly repeated measures. Our familiarity with pre-harvest, in-field cabbage yield prediction and associations between direct, instrumented and human assessments of lettuce leaves led us to ask if digital imagery could be employed to greater benefit in lettuce production and research. Specifically, could image acquisition and analysis complement or substitute for standard, destructive measures of fresh biomass (yield)? If yes, under what conditions? Field and greenhouse plantings of red- and green-leaved lettuce direct-seeded (2700 seed/m<sup>2</sup>) into 0.61 m × 0.61 m × 0.15 m raised beds and 0.3 m × 0.3 m × 0.05 m plastic trays were established at the OARDC in Wooster, OH over four seasons in 2008 and 2009. Seedling images (.jpg format) were captured on days 7–30 after sowing at approximately 0.61 m above the crop canopies at variable times during the photoperiod using handheld and tripod-mounted digital cameras focused on a 0.3 m × 0.3 m grid within the plot. Live plant samples representative of the digital image were also collected by hand and processed, recording tissue weight and leaf area. A total of 384 field and 168 greenhouse images were taken Oct. 2008–Nov. 2009 and analyzed using preset and user-defined settings in WinCam™ (Regent Instruments, Canada) software. These settings and the reference grid in the image allowed the software to calculate the area of the image covered by crop canopy. Differentiating leaves and rooting medium background was least reliable in images containing red leaves and providing sufficient contrast between the background and the leaf material was a consistent hurdle. Nevertheless, Pearson correlation coefficients (r) between computer-generated and direct measures of leaf area in the greenhouse study were 0.93–0.96 10–14 days after sowing. And, in field studies, r values for correlations between direct measures of plant biomass and WinCam™-derived estimates of leaf area were 0.76–0.94 (P < 0.0001). We conclude that digital



image analysis may be useful in real-time, non-destructive assessments of early-stage lettuce canopy development, particularly in settings dominated by green leaves.

*Specified Source(s) of Funding:* OSU/OARDC-OSUE

4:30–4:45 pm

### **Nitrogen Requirements for Lettuce Production**

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As California vegetable growers face increasing regulation to protect environmental water quality there is a need to reevaluate established N fertilization practices. Growth and N uptake were studied in lettuce (*Lactuca sativa* L.) grown in the temperate coastal valleys of central California. Growth and N uptake in 15 commercial iceberg and romaine lettuce fields were monitored; all fields had  $>20 \text{ mg} \cdot \text{kg}^{-1}$  residual soil  $\text{NO}_3\text{-N}$  at the time of first N sidedressing, a common phenomenon in this production area. Two levels of N fertilization were established in each field by eliminating or reducing the cooperating growers' first sidedress application in a portion of the field. Whole plant samples were collected every 7 to 10 d for determination of aboveground biomass and N content. Seasonal N fertilization by the growers averaged  $153 \text{ kg} \cdot \text{ha}^{-1}$ , while the reduced N plots averaged  $76 \text{ kg} \cdot \text{ha}^{-1}$ . Total fresh and dry biomass at commercial harvest averaged 99 and  $4.5 \text{ Mg} \cdot \text{ha}^{-1}$ , respectively, with no significant difference between the grower and reduced N regimes. Crop N uptake and biomass accumulation was minimal up to the rosette stage of growth (approximately 4 weeks after planting), and then increased linearly until harvest (approximately 9 weeks after planting). Mean dry biomass accumulation during the rapid growth phase was  $110$  to  $130 \text{ kg ha}^{-1} \text{ d}^{-1}$  and mean N uptake was  $4$  to  $5 \text{ kg ha}^{-1} \text{ d}^{-1}$  at the summer temperatures prevalent in this production region. Biomass N at harvest averaged  $154$  and  $146 \text{ kg ha}^{-1}$  in the grower and reduced N regimes, respectively; the small difference indicated highly inefficient crop utilization of the first sidedress N application. Lettuce showed modest seasonal N uptake; when significant residual soil N is present, limited N fertilization is necessary.

4:45–5:00 pm

### **Fecal Coliform Level Determination in Surface Water Used for Irrigation in New Jersey**

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A water quality assessment is necessary when fruit or vegetable operations are evaluated for possible sources of microbial contamination. Surface water irrigation has become more of a concern as reported food-borne illnesses have increased. Irrigation water in New Jersey was analyzed for fecal coliform to determine if another water source should be selected or a treatment system installed. A 2-year study was carried out to determine fecal coliform levels in surface water used for irriga-

tion. Five locations were sampled on a weekly using standard procedures recommended by the commercial laboratory analyzing the samples. Sampling locations consisted of 1) a river with suburban and industrial areas up stream, 2) a spring-fed pond with some runoff from surrounding fields, 3) a dam on a stream with agricultural areas up stream, 4) a spring-fed pond with no runoff entering, and 5) a pond located in an agricultural area with runoff from surrounding fields and wildlife activity. In 2008, fecal coliform mean levels (colony forming units/100 mL of water) for four sampling dates were lowest at locations 2 and 4 (33 and 61 cfu/100 mL) and highest at location 5 (1339 cfu/100 mL). The river site (location 1) averaged 283 cfu/100 mL while the dam (location 3) had 174 cfu/100 mL. In 2009, ten dates were sampled to better monitor the whole production season. The results were similar to 2008 where locations 2 and 4 had the lowest levels of fecal coliform (176 and 49 cfu/100 mL) and the highest at location 5 (289 cfu/100 mL). Location 1 (river site) averaged 293 cfu/100 mL and the dam location (3) averaged 138 cfu/100 mL. The river (location 1) and runoff pond site (location 5) had levels above what would be considered acceptable in New Jersey for irrigation water (200 cfu/100 mL). Mean high colony counts for fecal coliform were the result of runoff during rain events and wildlife pressure. In these locations, growers should irrigate from a ground water source or use a pond where there is little chance of runoff or wildlife activity.

*Specified Source(s) of Funding:* Charles E. and Lena Maier Research Fund

5:00–5:15 pm

### **Humic Substances Provide No Consistent Agronomic Benefit in Representative Field Soils**

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Soil application of humic acid (HA), generally derived from Leonardite shale, is a common practice in California vegetable production. Five commercial HA formulations were evaluated for their effects on soil microbial activity, seedling emergence, crop productivity and nutrient uptake when applied to representative agricultural soils. Two soils differing in organic matter content (8 and  $25 \text{ g} \cdot \text{kg}^{-1}$ ) were wetted to field capacity moisture content with solutions of water, N and P fertilizer, HA, or fertilizer + HA, and incubated aerobically at  $25 \text{ }^\circ\text{C}$ . In the lower organic matter soil a synergistic effect of fertilizer and HA was observed after 7 d of incubation on both microbial respiration and the amount of phospholipid fatty acids detected; these stimulatory effects were not observed in the higher organic matter soil. In a greenhouse pot study the effects of HA on seedling emergence, dry mass accumulation and P uptake of romaine lettuce (*Lactuca sativa* L.) were evaluated in four soils of low P availability; HA was applied to the soil at a rate simulating a field application of  $2.2 \text{ kg} \cdot \text{ha}^{-1}$  a.i. HA had no significant effect on emergence rate or percentage, or P uptake, in any soil; plant dry mass was increased with HA in one soil. Field trials were conducted in 2008 and

2009 evaluating the effects of pre-transplant soil application of HA at 1.1 or 3.4 kg·ha<sup>-1</sup> a.i. on growth, nutrient uptake and fruit yield of processing tomato (*Lycopersicon esculentum* Mill.). In neither year was macro- or micronutrient uptake increased with HA. Similarly, there was no significant HA effect on plant dry mass accumulation or fruit yield.

5:15–5:30 pm

### Estimating Nitrate Leaching in Lettuce Production

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In Salinas Valley, there is potential for nitrate leaching to occur in intensive lettuce production. Lettuce is a high value crop and sidedress fertilizer costs represent a small fraction (<5%) of total crop production costs. To ensure maximum yields, there is a tendency for fertilizer application rates to exceed crop nutrient requirements. As a result, there is potential for significant nitrate leaching if excessive irrigation is applied during the growing season. Little research has been conducted to quantify nitrate leaching in lettuce production under a range of N fertilization rates. The goal of this project was to estimating nitrate leaching using suction lysimeters and to identify best management practices that can reduce nitrate leaching in lettuce production. The trial was conducted at the Hartnell East Campus Research Facility Salinas, CA on a Chualar loam soil. Romaine lettuce was planted on 23 June. UAN 32 was applied through drip irrigation at 11 (zero sidedress), 84, 168, 252 and 336 kg·ha<sup>-1</sup> of N. Irrigation water was applied at 116% of ET which was representative irrigation amounts applied in the area. To measure leachate, suction lysimeters were placed below the root zone at 60 cm deep in the plant seedline in each plot; suction was maintained at 20–30 kPa using small suction pumps. Leachate was collected 24 hours after each irrigation; the quantity of nitrate leached was estimated from the concentration of nitrate in the lysimeter leachate and water movement in soil which was estimated by soil water measurements made with a neutron probe (before and after each irrigation) and accounting for crop evapotranspiration (ET). No significant differences were seen in lysimeter leachate nitrate concentrations until 56 days after germination, after which one or more fertilizer treatments had significantly greater nitrate-N than the zero sidedress treatment. Between 18–32% of the N leached during the season occurred with the water applied to germinate the crop. Maximum yield was obtained at 168 kg·ha<sup>-1</sup> of N, but the total nitrate-N ha<sup>-1</sup>

leached at this fertilizer rate was 78 kg·ha<sup>-1</sup> of N, which was also equivalent to the 252 and 336 kg·ha<sup>-1</sup> of N fertilizer rates. Over 45 kg·ha<sup>-1</sup> of nitrate-N was leached from the zero sidedress treatment which indicates that mineralization of soil organic matter can also contribute significant nitrate that can be leached by over irrigation.

Specified Source(s) of Funding: none

5:30–5:45 pm

### Commercial Extract from the Brown Seaweed *Ascophyllum nodosum* (Acadian®) Improves Early Establishment and Helps Resist Water Stress in Vegetable and Flower Seedlings

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Many vegetable and ornamental bedding plant crops are grown in plug trays and cell packs under greenhouse conditions prior to transplantation into the field or landscape. The development of a large, healthy root system is important for young seedlings to help withstand the inevitable transplantation shock. Commercial extracts of *Ascophyllum*, are known to improve root development of horticultural plants as well as to help alleviate some symptoms typically associated with abiotic stresses such as drought. Greenhouse experiments in Cornwallis, Nova Scotia were designed to test the effects of Acadian® seaweed extract on root development in lettuce, melon, tomato, pepper, celery, petunia, pansy and cosmos. Acadian® treatments, in combination with 10N–52P–10K fertilizer, were applied as a drench and compared to plants which received only 10–52–10 as control. The roots and leaves of plants from each treatment were examined with WinRhizo® root and WinFolia® leaf image analysis systems. Time lapse videos were also used to record results. Replicated trials showed significant improvements in root length, surface area, volume and leaf area when the Acadian® was applied in combination with fertilizer. Further studies examined the effects of this commercial seaweed extract on water stress in pepper, lettuce, tomato, petunia and pansy.

Results showed that plants treated with Acadian® plus fertilizer were more water stress tolerant than those treated with fertilizer only. The application of Acadian® extended the time before the plants began to succumb to water stress compared to fertilizer treated controls. These results suggest that applications of the *Ascophyllum*-based, commercial extract improves early root and shoot development and provides protection against water stress under the conditions tested. All of these positive attributes have important commercial applications, particularly for greenhouse operators and suppliers of bedding plants.

## Tuesday, August 3, 2010 Springs A & B Oral Session 24: Nursery Crops 1

4:30–4:45 pm

### A Comparison of “Air Root Pruning” and Conventional Plastic Containers for Cultivation of Two Palm Species

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As monocotyledonous plants, palms have an adventitious, uniform root system usually branching to few orders. Palm roots often branch when pruned, however, making a compact network. In nursery production, some containers have various types of air holes cut into the side walls, which are purported to increase root production by “air pruning.” We evaluated the effect of seven plastic containers (two without holes [standard], one with slit-like holes, two with line-like holes, and two with round holes) on the growth of two palms: kentia (*Howea forsteriana*) and king (*Archontophoenix cunninghamiana*). Container volume varied from 10,196 to 29,102 cm<sup>3</sup> and significantly affected new leaf production: palms growing in larger containers produced more leaves. King palms grew the largest stems in standard containers. Kentia palms showed no difference in stem caliper when grown in a standard container or one with line-like holes. The container with slit-like holes produced king palms of the poorest quality and size, likely because potting media was more readily flushed through the openings of this type of pot during irrigation. By contrast, containers with round holes produced kentia palms with the smallest stem caliper size. In summary, containers with air holes in the side walls did not increase palm leaf production or stem caliper size but larger containers did increase these growth parameters.

4:45–5:00 pm

### Scheduling Irrigation Based on Plant Daily Water Use Conserves Water without Decreasing Growth of Container-grown Ornamental Shrubs

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In many regions of the U.S. regulations are in place or impending that regulate water use by nurseries. The primary strategy to meet these regulations is to modify irrigation practices to reduce irrigation inputs. A study was conducted using 8 landscape shrub taxa potted in 10.2L (#3) containers in 85% pine bark: 15% (vol:vol) peat substrate to examine the impact of three daily water use (DWU) irrigation treatments versus a conventional irrigation regime on plant growth. Irrigation was applied through an overhead system at four levels: 1) control application of 19 mm-ha 2) irrigation applied to replace 100% DWU, 3) applications alternating 100% DWU with 75% DWU in a 2-day cycle, and 4) a 3-day application cycle replacing 100% DWU on the first day and 75% DWU on the second and third days. Each treatment was replicated 3 times with 6 subreplications of each taxon per treatment. An ML2x ThetaProbe was used to measure substrate volumetric moisture content (SVMC) at 30 minutes and 24 hours after irrigating to calculate DWU ( $DWU = SVMC_{30min} - SVMC_{24hr}$ ). Subsequent DWU calculations were made every 3 weeks throughout the growing season to adjust volume of water applied. Considering all taxa and treatments, total irrigation applied by the three DWU treatments was reduced by 16% to 57% compared to the control. Only DWU of *Weigela florida* ‘Alexandra’ exceeded the control by 12% during one 14-day interval between DWU measurements. Growth index (GI) [(plant height + width A + width B perpendicular to A) / 3] taken the last week of the experiment indicated that all taxa in DWU treatments were the same size or larger than control plants. Electrical conductivity using the PourThru method was measured for all taxa and at no time exceeded the maximum recommended levels. Foliar nitrogen concentration in *Hydrangea paniculata* ‘Limelight’, *Itea virginica* ‘Morton’, *Physocarpus opulifolius* ‘Seward’, *Spiraea media* ‘Darsnorm’, and *Weigela florida* ‘Alexandra’ did not differ ( $P \geq 0.05$ ) between treatments.

Foliar concentrations of P and K for the DWU treatments were the same as or greater than the control.

*Specified Source(s) of Funding:* MSU Project GREEN, MDA Hort Fund, Spring Meadow Nursery, Renewed Earth, Harrell's Inc.

5:00–5:15 pm

### **Growth and Physiology of Container-grown Conifers under Cyclic Irrigation Regimes**

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Water use regulations and the cost of applying water are increasing as the availability of potable water is decreasing. Irrigating ornamental nursery stock cyclically, or applying daily water allotments in multiple irrigation events, instead of the traditional once daily application may lead to increased water use efficiency (WUE). The objective of this study was to quantify the effects of varying irrigation regimes on the growth and physiology of common container-grown conifer species in pot-in-pot production. Four species of conifers (*Abies fraseri*, *Picea pungens*, *Picea glauca* var. *densata*, *Pinus strobus*), grown in #3 and #7 containers, were randomly assigned to irrigation regimes with varying combinations of amounts (low, medium, high) and cycle frequencies (once or 4 times daily). Daily amounts for #3 containers were based on 75%, 150%, or 225%  $ET_0$ , and amounts for #7 containers were based on 75% or 150%  $ET_0$ . Water was applied using pressure-compensating drip emitters or spray stakes. Mid-day gas exchange and monthly tree caliper and height were measured in 2008 and 2009. Diurnal gas exchange and water potential of *A. fraseri* grown in #7 containers were measured on two dates during each growing season, and substrate media temperature and moisture of #7 containers were monitored throughout the season. Across all species, trees receiving 150% and 225%  $ET_0$  had higher stem radial growth in 2009 than trees irrigated with 75%  $ET_0$ , regardless of container size. Response to irrigation varied among species. *Pinus strobus* grown in #7 containers had increased stem radial growth in 2009 when irrigation was applied in four cycles compared to a one cycle; however, the number of irrigation cycles had no effect on growth of trees in #3 containers. Responses of assimilation, conductance, and WUE differed depending on sampling date. Mid-day net assimilation of *P. glauca* and *P. pungens* and

stomatal conductance of *P. pungens* grown in #7 containers increased with cyclic irrigation on one sampling date (6 Aug. 2009); however, WUE of trees grown in #3 and #7 containers was unaffected by cyclic irrigation. Multiple irrigation applications have potential to alleviate mid-day water stress. Differences in responses between species could be due to tree size, growth rate, and morphological differences.

*Specified Source(s) of Funding:* Michigan Ag Experiment Station Project GREEN Michigan Christmas Tree Association Michigan Department of Agriculture Horticulture Fund

5:15–5:30 pm

### **Nursery Field Fertilizer Evaluations in Ontario and Ohio**

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The green movement in the United States has forced examination of past practices to determine whether they are environmentally sound and based on scientific research. Fertilization practices by the green industry need to be examined closely to insure that growers are using nutrients in the most efficient and environmentally friendly method. Twelve fertilizers or practices were tested at two cooperating nurseries in Ontario, Canada (Connon AVK, Christie Farm, West Flamborough, ON and Braun Nurseries, Fiddler's Green Farm, Anacaster ON), one in Ohio (Sunleaf Nurseries, Madison, OH) and one test site at Ohio State Univ (Waterman Farm, Columbus, OH). Tree liners of three species *Acer rubrum* 'Red Sunset' or *Acer rubrum* 'Embers' (Connon AVK), *Pyrus calleryana* 'Chantclair' (at all sites) and *Quercus rubrum* were planted in mid May, Ontario, late April, 2009, Ohio to be grown for three years. Not all 12 fertilizer treatments, with exception of the Anderson products, were evaluated at all sites. The fertilizers evaluated are field dry-soluble (standard practice) of 100#/ac granular 19–19–19 supplied by The Andersons, CRF's: Osmocote 33–3–6, Osmocote 22–3–8 (The Scotts Co. LLC, Marysville, OH), Polyon 36–3–6, Polyon 20–6–13 (Agrium Advanced Technologies, Brantford, ON), Anderson DG 9135, 23% and Anderson 9136, 33% (The Andersons Turf and Specialty Group, Maumee, OH), Acer 23–4–9, Acer 34–5–5, (Plant Products Co. Ltd., Brampton, Ontario), 50# fertilizer June and 50# in September at Connon AVK as a conventional practice and liquid feed as a conventional practice at Sunleaf Nurseries as farm grade, bulk, 100 # liquid UAN 28% and 100 # potash granular. All fertilizers were applied to deliver 100 # N/acre to be distributed in a 9 sq ft area around each tree. Over location and species the two Anderson fertilizer tested were not significantly different from

one another and tested as well as industry standards of Polyon and Osmocote. In this first year of study growth was enhanced with 100-lb N applications versus no fertilizer. No fertilizer had more detrimental effects on maple growth over location. The Osmocote 22–3–8, Polyon 20–6–13 and the Acer 23–4–9 were the only fertilizers that contained minors and were the treatments that produced the greatest increases in caliper.

*Specified Source(s) of Funding:* Ohio Staet Univ, OARDC and The Anddersons Turf and Specialty Group

5:30–5:45 pm

### **Seed Propagation of *Chionanthus pygmaeus* (Pygmy Fringetree), a Rare Woody Species Native to Florida**

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*Chionanthus pygmaeus* Small (pygmy fringetree) is an endemic and rare Florida species, which has an attractive, small habit giving it great potential for use in managed landscapes. Members of the genus *Chionanthus* are difficult to propagate via cuttings and possess complex seed dormancies that are not well understood. Both conservation of *C. pygmaeus* and its potential for commercial propagation for use in managed landscapes is dependent on a better understanding of its complex seed dormancy and enhancement of its propagation. This study was conducted to determine what factors are involved in overcoming seed dormancy and to assess what environmental factors might be influencing the ostensible reduction in the natural reproduction of *C. pygmaeus* in its native habitat. Evaluation of sexual propagation methods for *C. pygmaeus* will help to understand its biology, potential for conservation, and likelihood for commercial propagation. Various scarification treatments, which replicated conditions propagules are exposed to in the wild, were investigated to determine their effects on germination of 20-year-old seeds originally collected from the species' native range. Treatments included endocarp removal, sulfuric acid, boiling-water, and smoke-water treatments. Prior to treatment initiation, seed viability was estimated to be 12%. Treated seeds went through two cold- and two warm-stratification periods of 4 and 25 °C, respectively, in a dark growth chamber. After 180 days, no treatments induced early germination. Seeds were then tested for viability and found to have overall viability of 10.5%. Seed viability of seeds in the scarification treatments were 13.0% (boiling water), 9.4% (sulfuric acid), 22.4% (boiling water × sulfuric acid), 0.0% (endocarp removal), and 7.8% (control). Seed viability of seeds in the smoke-water treatments were 9.6% (control), 10.4% (50% dilution), 7.5% (25% dilution), and 14.6% (12.5% dilution). Seed viability for scarification x smoke water treatments ranged between 0.0–27.1%. Although there was only a slight reduction from the expected viability (12%) to the end-of-experiment viability (10.5%), it appears some of the treatments, particularly endocarp removal with a final viability

of 0%, were associated with a reduction in seed viability. Certain treatments may be associated with maintenance of viability. It is apparent that seed dormancy of the species is highly complex, allowing 20-year-old seeds to retain some degree of viability while having no germination success.

*Specified Source(s) of Funding:* Hatch

### **Wednesday, August 4, 2010 Springs K & L Oral Session 25: Nursery Crops 2**

8:00–8:15 am

#### **Determining Media and Species Effects on Soil Carbon Dynamics in the Landscape**

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Increased atmospheric carbon dioxide (CO<sub>2</sub>) concentration is an important factor in global change research. While agriculture is a major contributor to greenhouse gas (GHG) emissions, it has great potential to offset emissions by altering management practices. Much of the work on reducing GHG emissions and enhancing carbon (C) sequestration has been conducted in row crop and forest systems. Horticulture is a multi-billion dollar industry, but no research has focused on the industry's impact on global change. Baseline estimates of C emissions and the ability of growers/landscapers to sequester C using current production practices must be evaluated. This work investigated the effects of growth media and species on soil C dynamics. Two commonly grown nursery crops [crape myrtle (*Lagerstroemia* × 'Acoma') and magnolia (*Magnolia grandiflora* 'D.D. Blanchard')] were transplanted (from 3- and 4-inch liners, respectively) into 3-gal containers on 25 Mar. 2008. Three growth media mixed with standard amendments were used: 1) pinebark (PB) (industry standard); 2) WholeTree (WT); and 3) clean chip residual (CCR). WholeTree and CCR are forestry industry byproducts currently being evaluated as alternative potting media due to decreasing PB supplies. Plants were outplanted to the field in Winter 2008. In Summer 2009, plots were sampled for soil C and an automated carbon dioxide efflux system (ACES) was installed to continuously monitor C lost via soil respiration

(24 h·d<sup>-1</sup>) from each potting media/species combination; non-plant (bare soil) areas were also monitored. The main effect of species showed that crape myrtle CO<sub>2</sub> efflux was higher than magnolia. The main effect of media indicated that while PB and CCR were similar, both had higher CO<sub>2</sub> efflux than WT. The interaction of treatment variables showed that crape myrtle had higher flux than magnolia in all media. Further, in crape myrtle all three media had significantly different CO<sub>2</sub> efflux values with CCR highest and WT lowest. In magnolia, PB had higher values than the other two media. Soil C analysis indicated that PB had higher C content than the other two media; however, all media dramatically increased soil C content compared to native soil. It is clear that placing container media into the landscape will increase soil C; the length of time this C remains in the soil requires further investigation, but may vary by media type.

*Specified Source(s) of Funding:* Hopefully my major professor will pay for the trip.

8:15–8:30 am

### **Foliar Nutrition and Leaf Chlorophyll Index of Container-grown Shade Trees in Response to Controlled-releaser Fertilizer**

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Nutrition management is one of the most important components of managing ornamental tree nursery crops. Controlled-release-fertilizers (CRF) provide growers with a means to ensure adequate nutrition is available for tree growth through the growing season while reducing the potential for off-site nutrient movement. The goal of the present study is to determine the response of trees from two ash alternative species; ‘State street’ maple (*Acer miyabei* ‘Morton’) and ‘Harvest gold’ linden (*Tilia cordata* × *mongolica* ‘Harvest gold’) to controlled-release fertilizer (15–9–12, Osmocote-Plus, Scotts, Inc., Marysville, OH). One and one-half inch (4 cm) caliper nursery liners were planted in 25-gal (95 L) containers in 80:20 (v:v) pine bark and peat moss and grown on for 2 years. Each spring containers were top-dressed with 200, 275, 350, 425, 500, or 575 g of CRF. Response variables measured included caliper and height growth, foliar nutrition and SPAD chlorophyll index. Fertilization rate did not affect ( $P>0.05$ ) total stem caliper growth or height growth of trees from either species. SPAD index values showed a pronounced seasonal pattern, increasing through the spring and then reaching a plateau through the summer. Mid-summer SPAD values varied between species ( $P<0.001$ ) with mean values averaging 5–6 units

higher in linden trees than in maple trees. Fertilization increased ( $P<0.05$ ) SPAD values of trees from both species during the midsummer period. SPAD index values were highly correlated ( $P<0.001$ ) with foliar nitrogen concentration of trees from both species. For maple trees, SPAD was correlated ( $P<0.01$ ) with foliar phosphorus, potassium, and sulfur. For linden trees, SPAD was correlated ( $P<0.05$ ) with foliar phosphorus and iron. Foliar magnesium and calcium were negatively correlated ( $P<0.05$ ) with foliar potassium suggesting an antagonism between uptake of potassium and the other cations. The relative lack of growth response of trees from both species suggests that the lowest rate (200 gram per container) of CRF may be adequate to produce acceptable caliper growth in these trees. The increase in foliar nutrients, including nitrogen, phosphorus and potassium, without a concomitant increase in growth suggest luxury consumption of these elements had occurred. Rates of potassium addition should be monitored closely given the apparent antagonism between uptake of potassium and uptake of magnesium and calcium, particularly in linden trees. The broad plateau for SPAD levels observed indicates that comparative samples may be collected at any point during the summer.

*Specified Source(s) of Funding:* Scotts, Inc., Michigan Ag Expt. Station Project GREEN, J. Frank Schmidt and Sons Nursery

8:30–8:45 am

### **Effect of Fertilizer on Growth and Physiological Response of *Zanthoxylum ailanthoides* Sieb. et Zucc. Seedlings**

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*Zanthoxylum ailanthoides* Sieb. et Zucc., a native plant in Hunan, China, has a great potential for an ornamental plant or timber plantation. To better manage its seedling production, nine fertilizer combinations of urea (0, 3, 6 g/pot), calcium superphosphate (CP; 0, 2, 3 g/pot) and potassium chloride (PC; 0, 2, 3 g/pot) were applied to potted seedling plants. Fertilizers significantly influenced the seedling growth (measured by plant height (cm) and caliper size (mm)). All plants received fertilizer(s) were significantly taller and bigger than that (19.6cm and 4.6mm) of the control. The height reached 76.9cm and caliper diameter was 11.9mm under the fertilizer treatment of 3g urea + 3g CP per pot. Regression analysis indicated that nitrogen had much stronger influence than that of phosphorous and potassium. The proper

nitrogen level should be 3g urea per pot. Too higher (6g/pot urea) greatly reduced seedling growth, especially with increased phosphorous levels from 0 to 2 to 3g/pot CP. Regardless of P or K levels, caliper sizes ranged from 11.5 to 12.4mm under application of urea for 3 or 6 g/pot. Total dry weight, root weight, leaf area index had the similar trend as the plant growth. The ratio of root to shoot was higher in the lower concentrations of N, P, and K. It was clear that shortage of nutrient should increase in root/shoot ratio, which led to more roots to take nutrients from soil. Chlorophyll content (CC) and photosynthesis rate (Pn) increased significantly as the N-P-K concentrations went up. Both CC and Pn doubled under the highest combination of three fertilizers. Seedlings could be much higher and stronger if we applied 3 g urea + 2 g CP + 3 g PC per pot during their growing season.

8:45–9:00 am

### **CCROP—A Web-based Decision Tool Enhances Irrigation and Nutrient Management Decisions for Container Nursery Managers**

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CCROP (Container Crop Resource Optimization Program) is a web-based decision support tool that simulates growth, nutrient, and irrigation requirements of woody ornamental container-grown crops. CCROP is used to assist growers/managers and other industry stakeholders select best management practices that maximize use of water and fertilizer resources and minimize environmental impact. Inputs for CCROP include daily weather data uploaded from the Florida Automated Weather Network (FAWN) as well as critical management practices (e.g. plant date, container size and spacing, fertilizer, pruning, etc.). Outputs include plant growth, evapotranspiration, irrigation requirement, nutrient uptake, and leaching of applied nutrients. A real-time tool recommends daily water application based on resupplying that which is lost through evapotranspiration. Examples of simulations used to choose the best practices to implement and associated costs will be presented and discussed.

*Specified Source(s) of Funding:* USDA/ARS Floral and Nursery Research Initiative and HRI

9:00–9:15 am

### **Crop Response to Hybrid Poplar Alternative Soilless Substrate Component for Pacific Northwest Ornamental Container Production**

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Douglas fir bark (DFB) is the primary component used in soilless substrate to grow woody ornamental plants in the Pacific Northwest. Bark is a by-product of the timber industry and is used for landscape mulch, a soilless substrate component, or bio-energy. The decline in the housing market and rise in energy generation from renewable resources has resulted in a diminishing bark supply for container nurseries. Thus, the price of bark has been unstable and shown an overall increase over the last two years. Additionally, nurseries have reported reduced bark supply and decreased consistency. This increasing need for alternative substrates has prompted evaluations of economically feasible, regionally available materials that occur within the Willamette valley. Initial research conducted at Oregon State Univ investigated the use of 9–25 mm whole tree hybrid-poplar (WTP) as a substrate alternative. Two experiments utilizing a premixed soilless substrate containing 20% (v/v) screened pumice, 20% fine DFB (9 mm minus), 60% coarse DFB (9–25 mm) was altered by replacing coarse DFB with 0, 20, 40, and 60% (v/v) WTP. Liners of *Acer palmatum*, *Hydrangea macrophylla* 'Endless Summer', *Juniper horizontalis* 'Youngstown' and *Euonymus fortunei* 'Moonshadow' were potted into 8 L containers. The experiment was conducted using completely randomized design with eight individual plant replications for each taxa within a treatment. The second experiment used liners of *Cotoneaster dammeri* 'Coral Beauty' organized in a completely randomized block design (3 blocks x 4 treatments), where each treatment within each block was independently irrigated to observe the effects of WTP on plant water use. All plants were planted on April 23, 2008. *Cotoneaster* were harvested on August 4<sup>th</sup>, 2008, whereas the other taxa were harvested on May 8<sup>th</sup>, 2009. Growth index (height x width x width), a measurement of plant growth, on euonymus, maples, junipers and hydrangea, showed that a 20% (v/v) addition of WTP produced the largest plants. *Cotoneaster* root to shoot ratio linearly increased with increasing WTP. This increase was a result of shoot weight. Root weight was unaffected by substrate treatment. *Cotoneaster* water use

efficiency linearly decreased 26% with increasing WTP, producing > 6 g more dry mass per mL of water used. When WTP was incorporated there was greater substrate shrinkage (>4 mm decrease in substrate column height). Other alternative substrates currently being evaluated in Oregon include bamboo, Christmas tree culls, shade tree culls, straw, and forestry slash.

*Specified Source(s) of Funding:* Phillips' Soil Products Inc., Canby, OR and USDA-ARS (SCA# 58-3607-8-714)

9:15–9:30 am

### Water Use and Growth of Two Woody Taxa Produced in Varying Indigenous Douglas Fir Based Soilless Substrates

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In the Pacific Northwest (PNW) container crops are grown in soilless substrates that contain different percentages of Douglas-fir bark (DFB), sphagnum peat moss and pumice. Previous research conducted by Gabriel et al. found varying combinations and ratios of these components result in differing physical and hydrological properties. These differences can significantly affect water management and consequently crop growth and water use. Caron et al reported up to 22% water savings by increasing the proportion of peat in soilless substrate while producing *Viburnum odoratissimum*. This was attributed to altering substrate physical properties, primarily increasing substrate available water. The objective of this study was to investigate the effect of conventional PNW soilless substrate mixtures on water use and subsequent crop growth of *Weigela florida* 'Polka' and *Azalea* 'Girard's Fuchsia'. In 2008 plants were potted in 3-gal (11 L) pots using DFB based soilless substrates containing 0%, 15%, 30%, and 45% (v/v) pumice or peat moss. The experiment was conducted as completely randomized block design; 4 blocks with 4 plant replicates that were independently micro-irrigated to maintain 0.2 leaching fraction (LF = effluent ÷ influent). Photosynthetic water use efficiency (PWUE) was calculated for weigela at 1100 and 1600 HRS as the ratio of net photosynthesis and stomatal conductance measured on two plants from each replication 100 days after treatment initiation using an open portable gas exchange system. After 132 days root and shoot dry weight data, in conjunction with influent and effluent data, was used to calculate crop water use efficiency.

Weigela and azalea growth increased linearly 17% and 36%, respectively, when bark was amended with increasing amounts of peat. In addition, increasing peat resulted in increased root and shoot growth of weigela, whereas azalea root dry weight was unaffected by peat addition. The addition of pumice to the bark substrate had no effect on weigela or azalea growth. Weigela PWUE linearly decreased 25% with increasing addition of pumice. Crop water use efficiency was unaffected by substrate regardless of taxa. Weigela leaf length and area (LLA), another indicator of crop water status, linearly increased with increasing peat, whereas weigela LLA responded curvilinearly to the addition of pumice. Additions of pumice greater than 30% (v/v) resulted in decreased LLA. We conclude there is no apparent crop benefit for the addition of pumice to DFB based substrates, however peat addition resulted in increased crop growth and a possible increase in water use efficiency.

*Specified Source(s) of Funding:* USDA-ARS (CRIS: 6618-13000-11S)

### Wednesday, August 4, 2010 Desert Salon 1-3 Oral Session 26: Weed Control & Pest Management

8:00–8:15 am

#### Effect of Cropping Systems on Weed Population and Biomass

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A field experiment conducted at the South Coast Research and Extension Center in Irvine, California measured weed populations and their biomass in organic broccoli planted after two summer cover crops, cowpea (*Vigna unguiculata*) and marigold (*Tagetes patula*). The population density of the dominant weed species, *Portulaca oleracea* (common purslane), peaked at 370 plants per m<sup>2</sup> just before the first hand weeding in broccoli planted after summer fallow. The fallow treatment had 5x as many purslane as when broccoli followed cowpea and 11x more than the marigold treatment. Weed density wasn't significantly different between the treatments after the first weeding. However, by harvest, the population of all weed species was 4x higher in broccoli planted on previously fallow plots relative to those in the cowpea and marigold plots. During the same trial year, common purslane had the highest dry biomass for broccoli planted after summer fallow. Weed population density prior to first hand weeding followed a similar trend in 2008. Prior to hand weeding, there were 4x as many purslane plants in broccoli planted after the fallow treatment than for broccoli following either cowpea or marigold. Differences in weed population at broccoli harvest for the 2008 trial were also significant for the cropping systems, with 7x and 11x more common purslane when broccoli followed summer fallow than when broccoli was planted after cowpea or marigold,



respectively. Biomass of all weeds for the 2008 trial was greater in broccoli planted after summer fallow than those that followed summer cowpea or marigold plots. Broccoli height and canopy spread were greater following either cowpea, a nitrogen fixing legume, or marigold. Broccoli following cowpea or marigold had higher number and fresh weight of broccoli heads when compared to those grown after summer fallow. Similar trends were observed with the fresh weights of marketable broccoli heads. Broccoli plants grown after summer cover crops matured faster than those that were planted following a summer fallow. The lower densities and biomass of weeds in broccoli plants and the better vegetable growth and marketable yields following summer cover cropping are good indications that summer cover cropping reduces the intensity of weed populations and their competitive ability with subsequent vegetable crop production.

8:15–8:30 am

### **Influence of Tomato Shoot Pruning on Bacterial Spot Infestation**

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Two field trials were conducted to determine the effect of pruning on the incidence of bacterial spot (*Xanthomonas perforans*) and on growth and marketable yields of tomato (*Solanum lycopersicum*). Seedlings of 'Tygress' and 'Security 28' tomato were planted in fumigated beds and submitted to no pruning, light pruning (2 stems left) and heavy pruning (1 stem left) at 3 weeks after transplanting. Plots were left either to natural bacterial spot infestation or inoculated with  $1 \times 10^6$  cfu/mL. The results indicated that the three factors (cultivar, bacterial spot inoculation, and pruning) were not significant for plant height at 6 weeks. There was significant effect of each of the individual factors on total marketable fruit weight, but none of the interactions were significant. 'Security 28' and non-inoculated plants had higher total marketable fruit weight than plots planted with 'Tygress' and inoculated plants, respectively. There was no difference between plots with lightly-pruned plants and non-pruned plots, whereas heavy pruning reduced yields by 11% in comparison with no pruning.

8:30–8:45 am

### **Effect of Rootknot Nematode on Tomato Rootstocks in Non-fumigated Open Field Production**

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Soil fumigation has been an essential component of open field fresh market tomato production systems since the 1960's. Farming without fumigants has remained a challenge, in part because the management of many soilborne diseases has been achieved with conventional genetics. Building new plant systems using rootstocks grafted to market acceptable varieties is a common practice in protected agriculture but has not gained acceptance in open field production. The performance of tomato rootstocks in open field conditions (Pineda fine sand) under the care of a commercial grower was evaluated in a replicated field trial. A raised bed, plastic mulched production system with drip irrigation and fertigation was employed by the grower. The experimental site was located in St. Lucie County, FL. The experimental design consisted of 6 blocks with 10 treatments consisting of 2 scions ('Biltmore' and 'FL-47') grafted on 3 rootstocks ('Aloha', 'Multifort' and 'H-7997' - 50 plants per treatment block) in a randomized design. Controls consisted of ungrafted and self-grafted scions. Plant vigor as judged by overall plant growth as measured by plant height was significantly different for 'Biltmore' on 'Multifort' and ungrafted 'FL-47' then that of 'FL-47' on 'H-7997'. The severity of root galling from *Meloidogyne* spp. was greatest on self grafted and non grafted 'FL-47'. 'Biltmore' grafted onto 'Multifort' and 'Aloha' and 'FL-47' grafted onto 'Aloha' had no apparent root galling, indicating that damage from *Meloidogyne* spp was minimal on those rootstock/scion combinations. Nematode egg counts within root systems were greatest on the ungrafted 'Biltmore'. However, egg masses were not found when 'Biltmore' was grafted onto 'Multifort' and 'Aloha' rootstocks. No root galling was observed when 'FL-47' was grafted onto 'Aloha'.

*Specified Source(s) of Funding:* USDA CREES

8:45–9:00 am

### **Beet Necrotic Yellow Vein Virus—A New Threat to Spinach Production**

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Beet Necrotic Yellow Vein Virus (BNYVV) causes one of the most economically destructive sugarbeet diseases, rhizomania, which may reduce sugar yield by 100%. The virus has rod shaped particles containing four single stranded RNAs and is transmitted by the root-infecting parasite *Polymyxa betae*. Spinach is a known experimental host of BNYVV, but the

virus had not been reported to cause disease in spinach fields. To investigate whether BNYVV can cause disease in spinach, 8 commercial spinach cultivars were planted in two BNYVV infested fields and two control fields in Salinas, CA in 2009. Spinach plants in the BNYVV infested fields showed disease symptoms of yellow-green or light-green vein clearing, mottling or yellow-green chlorotic lesions on younger leaves as early as 28 days after planting (4–6 true leaf stage). Leaves may also become stiff, more crinkled, and necrotic. There was an increase of lateral roots and leaf number but a decrease of leaf weight compared to healthy plants. Infected plants often became stunted, deformed, wilted, and dead. Symptomatic leaves and roots from plants with or without leaf symptoms in BNYVV infested fields all tested positive for BNYVV by ELISA. There were significant differences in disease development among cultivars, with disease incidence ranging from 8% ('Unipack 277') to 44% ('Polar Bear'). A more aggressive (resistance-breaking) strain of BNYVV led to higher disease incidence in spinach than the wild type. Sugarbeet was widely grown in California 10 years ago. BNYVV and its vector can persist in soil for more than 20 years. The increasing acreage of spinach host may increase BNYVV in soil. Diseased spinach plants were found in a grower's field in Ventura County, CA recently and were tested positive for the aggressive strain of BNYVV. Therefore, BNYVV is a new threat to spinach production in California.

9:00–9:15 am

### **Effect of Soil Disturbance, Organic Matter, and *Trichoderma* on Survival of Peach in Soil Infested with *Armillaria mellea***

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Root rot caused by *Armillaria mellea* persists in soil for decades and causes loss of replanted trees in citrus, subtropical and deciduous orchards throughout the United States. Aside from soil fumigation, there are no known fungicidal controls for the disease. In 2004, bare root *Prunus persica* with 'Nemagard' rootstocks grafted to 'Saturn' scions were planted in an infested avocado orchard. Four planting treatments were applied an effort to deteriorate *Armillaria* inoculum and were compared to a standard-sized planting hole in a randomized complete block design with nine replications: large planting hole (2 m<sup>3</sup>); large planting hole with 0.33 m<sup>3</sup> fresh yardwaste amendment (not composted) mixed with the planting backfill; large hole with yardwaste and *Trichoderma* inoculant; and large hole with *Trichoderma* only. Each year, we measured trunk diameter and height and noted tree mortality. Trees with fresh

yardwaste amended in the planting hole were initially stunted during the first two years but increased in size so that there were no treatment growth differences by 2010. Likelihood of survival was greatest with a large planting hole (70% chance of survival) and least (6% chance of survival) with the standard planting hole. Neither the application of organic matter nor *Trichoderma* impacted tree survival. Soil disturbance during preparation of large planting holes may disrupt *Armillaria* inoculum surviving on old root pieces.

9:15–9:30 am

### **Management of Fire Blight Disease with Prohexadione-Ca**

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Fire blight caused by *Erwinia amylovora*, one of the most destructive bacteria, affects pome fruits and other rosaceous plants. Growing shoots are a major site of the disease infection, that can be more difficult to control than bloom infection because the susceptible period is long and conditions favoring the disease are not well defined. Prohexadione Calcium (PC) is a plant growth regulator that reduces longitudinal shoot growth by inhibiting gibberellin biosynthesis without affecting fruit set or yield. PC represents an alternative to antibiotics or heavy metal for the control of fire blight. The growth response to PC treatment is dependent on several factors, including total dosage applied, application timing, crop load, cultivar treated, and geographic region. PC allows growers of pome fruits that have experienced excess vigor problems to limit shoot elongation, reduce pruning needs, reduce the incidence of fire blight disease, and maintain light penetration into the lower canopy for good flower and fruit development. PC gives only a transient effect because it disintegrates relatively rapidly and is effective only in young shoots. The strategy described provides a safe and effective control of secondary fire blight. In our researches on apple, pear, quince and loquat, hopeful results were obtained on control of fire blight disease.

*Specified Source(s) of Funding:* This study was supported by Selcuk Univ Scientific Researches Coordinators

9:30–9:45 am

### **Effects of Host Resistance Inducers and Copper-based Bactericides on Plant Growth and Bacterial Canker (*Clavibacter michiganensis* subsp. *michiganensis*) on Tomato Seedlings**

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*Clavibacter michiganensis* subsp. *michiganensis* is the causative agent of bacterial canker of tomato (*Lycopersicon esculentum*). Seed borne pathogen caused wilting of tomato, browning of vascular tissue and formation bird eye spots on fruit. In the study, the effectiveness of plant growth regulator (Prohexadione-Ca (PC)), plant activator (hydrogen peroxide (HP)) and copper compounds

(copper sulfate pentahydrate (CSP) and copper hydroxide) were determined on plant growth and growth of bacterial population on three tomato cultivars 'Newton', 'Orient', and 'Vuslat'. The best chemical was HP on preventing of bacterial growth (39.26–48.61%). Only PC treatments have decreased plant heights (38–46%) and bacterial population (about 12%). CSP applications caused the most effective results on increasing of plant heights (11–19%) however bacterial population increased between 4.15–7.69% in all of the cultivars. If integrated properly in plant health management programs, plant activators and growth regulators can be useful on plant health and growth.

9:45–10:00 am

### Characterization of Plant Bacterial Pathogens Transmitted by Bean Seeds

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The acceleration in movement of germplasm and other genetic material around the world has been considerable potential threat to plant health. Bacterial diseases of bean (*Phaseolus vulgaris*) cause economically important losses in worldwide and the only practical methods for management are the use of pathogen-free seed, appropriate cultural practices and planting of resistant cultivars. In the study, bean seeds were collected from economically bean growing areas which based size of sowing field on 12 provinces of Central Anatolia region. Morphological, biochemical, physiological and molecular methods were used for identification of pathogens on the seeds. In the region, infestation ratios of *Pseudomonas savastanoi* pv. *phaseolicola*, *P. syringae* pv. *syringae*, *Xanthomonas axonopodis* pv. *phaseoli* *Curtobacterium flaccumfaciens* subsp. *flaccumfaciens* were determined on the seeds as 21%, 13%, 11% and 0.8%, respectively. It is important to determine the level of the diseases incidence in fields and spreading of the bean bacterial diseases and alert the farmers to apply quarantine regulations developed.

*Specified Source(s) of Funding:* This study was supported by Selcuk Univ Scientific Researches Coordinators

## Wednesday, August 4, 2010 Springs H & I Oral Session 27: Genetics/ Germplasm/Plant Breeding: Ornamental Crops 2

10:30–10:45 am

### Analysis of Genetic Diversity and Relationships in the China Rose Group

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The wild origin, early breeding history, and diversity of the China Rose group, including *R. chinensis* and its varieties, cultivars, and hybrids, are largely unknown. The aims of this study were to investigate the genetic diversity and relationships of the China Roses with related species and hybrids, including information in support of, or refuting, the hypothesis that these roses are the hybrid result of the wild *R. chinensis* var. *spontanea* and *R. odorata* var. *gigantea*. Ninety Rosa accessions, including China Roses, a Miscellaneous Old Garden Rose, Noisettes, early Polyanthas, Bourbons, Teas, and species from Sections Indicae and Synstylae were surveyed using 23 microsatellite primer pairs. The *trnH-psbA* chloroplast intergenic spacer was also sequenced for the China Roses, Misc. Old Garden Rose, and the species to look specifically at maternal relationships. A total of 291 alleles were scored for the 23 microsatellites, with alleles per locus ranging from 6–22 and averaging 12.65. A dendrogram based on Dice similarity and a three-dimensional Principle Coordinate Analysis (PCoA) graph were plotted with the data. In the cluster analysis, the similarity coefficients ranged from ~0.15–0.99, with the cultivated roses forming well-defined groups at about 0.45 similarity. These groups generally reflected the American Rose Society horticultural classifications. A large number of sports and synonyms in the China Rose group were identified through this analysis as well. The PCoA gave a better graphical representation of the relationships of the species and cultivars, and with the inclusion of the chloroplast sequence haplotypes, some maternal relationships could also be identified. This study shows that the cultivated China Roses are a closely related group and identified which accessions were likely Hybrid China Roses. The results also suggest that the China Roses were maternally derived from *R. chinensis* var. *spontanea*. Based on the microsatellites and chloroplast sequence haplotypes, the identity of the *R. odorata* var. *gigantea* accessions in this study are suspect, but the China Roses may also have this species in their background as the result of natural or artificial hybridization.

10:45–11:00 am

### Construction of the Genetic Linkage Maps for the Diploid and Tetraploid Rose using Simple Sequence Repeat (SSR) and AFLP Markers

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Low density genetic linkage maps for both the OBxWOB26 (Old Blush × (Basye's Thornless × Old Blush) diploid backcross population and the FCxGG (Fragrant Cloud × Golden Gate) tetraploid F1 population were constructed with 68 and 57 labeled SSR primers, respectively. These were multiplexed using fluorescently labeled (HEX and FAM) primers that after PCR

were run on a capillary sequencer (ABI 3100). This was done as a first step to develop a consensus rose map with European collaborators. Among 68 SSR markers, 53 primers were uni-parental markers, which are heterozygous in either the male or female parent, whereas 15 primers were bi-parental markers in which both parents were heterozygous. Moreover, 5 out of the 68 SSR markers, RhJ404, H9\_B01, RW11E5, RW8B8 and RhE3 were mapped to two or more loci each. Thus a total of 75 loci were mapped using JoinMap 4.0 to create a diploid map with seven integrated linkage groups covering a length of 413 cM with an average chromosome size of 59 cM. In the integrated diploid map, the morphological traits, recurrent bloom (R/r, seasonal/recurrent) and flower type (Blfo) were mapped near the markers Rh58 and Rh50 at a distance of 0.1 and 0.8 cM, respectively. Flower type (*Blfo*) was previously shown to be closely linked to the marker Rh 50 (Yan, 2005) in the 93/1-119 map. However, the phenotypic trait, presence of stem prickles although mapped to the same chromosome as recurrent bloom and flower type, was not located near any markers. Fifty seven SSR and seventy nine AFLP markers have been used to develop the linkage map for the tetraploid rose. These primers were assigned to 16 linkage groups and cover approximately 1232 cM of the genome with an average chromosome length of 88cM. The two integrated diploid and tetraploid maps will be combined to a unified map using JoinMap 4.0 in near future.

*Specified Source(s) of Funding:* Robert E. Basye Rose Breeding and Genetics Program

11:00–11:15 am

### **Molecular Marker Development using 454-Pyrosequencing in Four Species of *Penstemon***

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*Penstemon* represents a large number of drought tolerant, perennial species native to the Intermountain West and is considered to have great value as an ornamental plant. Despite its problematic complexity and enormity as a genus, it is especially

important in the application of environmentally wise landscaping practices, such as xeriscaping. 454 pyrosequencing, a relatively new high-throughput sequencing technology, is one of the fastest, most economical methods of genome sequencing. Using a genome reduction technique, which reduced the *Penstemon* genome complexity by 104 fold, we sequenced four species of *Penstemon* (*P. cyananthus*, *P. dissectus*, *P. davidsonii*, and *P. fruticosus*) with an expected 11.46 fold average coverage for each fragment and then aligned using Newbler de-novo assembler. These species were specifically chosen because two are phylogenetically close (*P. davidsonii* and *P. fruticosus*), another is phylogenetically distant (*P. cyananthus*) and one has been difficult to classify (*P. dissectus*). From one half plate of the pyrosequencer, about 733,000 sequences were produced with an average length of 392 bases; about 287 million bases were sequenced in total. Alignments produced contigs representing 0.545%, 0.578%, 0.499%, and 0.495% of the genomes of *P. cyananthus*, *P. dissectus*, *P. davidsonii*, and *P. fruticosus* respectively. SSRs and SNPs were mined from sequence data using MISA and custom Perl scripts. An average of 2311 true SNPs were found between any two of the four species of *Penstemon*. 301 total SSRs were discovered from an alignment of all four species. 97, 113, 49 and 58 SSRs were found from the individual alignments of *P. cyananthus*, *P. dissectus*, *P. davidsonii*, and *P. fruticosus* respectively. Both SNP and SSR markers, derived from these four species, will be utilized to detect genetic differences between species across the genus in order to refine the complex *Penstemon* taxonomy which will aid in breeding programs and further genetic studies.

*Specified Source(s) of Funding:* Department of Plant and Wildlife Sciences, Brigham Young Univ, Provo, UT

11:15–11:30 am

### **Physiological Traits Associated with Drought Tolerance in *Lantana***

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*Lantana camara* L. is a popular ornamental landscape plant that is widely used in the warmer portions of the United States. In addition to their ornamental value, *L. camara* is also a lower water use plant. The development of new cultivars that use water as efficiently as possible is important as a part of a breeding program. Two groups of maternally related genotypes, including diploid, triploid, tetraploid, pentaploid, and hexaploid lines, were derived from *L. camara* 'Gold' and *L. camara* 'Pink Caprice' and were used in this study. Additionally, 40 commercially available cultivars were included. The purpose of this study was to assess the efficacy of several screening methods for value as a selection tool and to examine the relative drought resistance among related genotypes and commercial cultivars. Xylem water potential, photosynthetic rates, stomatal conductance, tissue and

substrate water content at foliage death, days to wilt, and days to foliage death. Significant differences within the maternally related groups of genotypes were observed for all of the above mentioned parameters. Similar results were observed among the commercial cultivars. It appears that ploidy level has little influence on photosynthetic rates or stomatal conductance during drought stress in the genotypes studied. These results suggest that the inclusion of screening tools like physiological parameters in response to drought stress should allow more water-efficient cultivars to be selected more readily, leading to further breeding advancement and variety recommendation.

11:30–11:45 am

### Use of Petal Explants for Successful Transformation of *Chrysanthemum ×morifolium* ‘Orlando’ Mediated by *Agrobacterium tumefaciens*

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*Chrysanthemum* is among the most popular cut flower and potted plant crops in the floriculture industry. This situation has promoted studies on the development of an efficient gene transformation protocol in *chrysanthemum*. Previously it has been demonstrated that petal explants had higher regeneration efficiency than other explants for *chrysanthemum* ‘Orlando’, but use of petal explants for transformation has not been previously reported. Therefore, development of a transformation protocol using petal explants would be beneficial for future work inserting genetic traits of interest in *chrysanthemum*. Petals were surface-disinfected in a 70% (v/v) ethanol solution for 30 seconds and in a 1.5% (v/v) sodium hypochlorite solution for 10 minutes, followed by three rinses with sterilized water. After sterilization, petals were divided into two parts, terminal (position 1) and middle parts (position 2), and were cultured on the MS medium supplemented with 1.0 mg·L<sup>-1</sup> IAA, 1.0 mg·L<sup>-1</sup> BA, and 0.1 mg·L<sup>-1</sup> kinetin with 3% (w/v) sucrose and 0.8% (w/v) agar (shoot induction medium, SIM). In order to examine the effect of concentration of kanamycin, two experiments were conducted. In experiment 1, explants were cultured on a SIM supplemented with kanamycin (0.0, 2.5, 5.0, 7.0, or 10.0 mg·L<sup>-1</sup>) for shoot development, and in experiment 2, explants were cultured on the MS medium supplemented with kanamycin (0.0, 5.0, 10.0, 15.0, or 20.0 mg·L<sup>-1</sup>) for root development. The explants were submerged in a 25 mL *Agrobacterium tumefaciens* suspension (O.D. 0.8), harboring the binary vector LBA4404, containing the GUS gene and were shaken for 30 min. Inoculated petal explants were transferred on a SIM and co-cultured for 1, 2, or 3 days in the dark. Selections in experiment 1 were made at 7.5

mg·L<sup>-1</sup> kanamycin due to explant sensitivity to kanamycin and its suitability to prevent escape formation (non-transgenic plants). Selections in experiment 2 were made at 20 mg·L<sup>-1</sup> kanamycin because regenerated shoots did not induce roots and turned brown in color. A 2-day co-culture with *A. tumefaciens* significantly increased the number of transgenic plants. In order to confirm the efficiency of this transformation system, expression of the transgenic plant was demonstrated by polymerase chain reaction (PCR) analysis and GUS histochemical assay. Successful transformation of *chrysanthemum* ‘Orlando’ petal explants mediated by *A. tumefaciens* was confirmed in this research.

Specified Source(s) of Funding: BK21 Program

### Wednesday, August 4, 2010 Springs D & E Oral Session 28: Human Issues in Horticulture/Public Horticulture

10:30–10:45 am

#### Horticulture of the Taj Mahal

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The 17th century mausoleum in Agra, India, known as the Taj Mahal, has been long considered one of the most, if not the most, beautiful building, in the world. The structure is part of a large complex of buildings and gardens encompassing 1.7 ha. Although usually considered in terms of its architecture, the building and grounds are rich in horticulture. The gardens in the Persian style, although considerably altered from the original, are justly famous. The external and internal walls are richly ornamented with bas reliefs of plants and decorations of stone inlays rich in floral imagery that combine Persian, Western, and Indian influences. Many of the plants are geophytes including tulip, narcissus, and iris. The architecture, garden, and decoration of the Taj Mahal are considered the pinnacle of Indo-Mughal art.

10:45–11:00 am

#### Sustaining School Gardens

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*Food for Thoughts*, Univ of Nevada Cooperative Extension school gardens program, has been in effect for more than seven years. During that time, staff has worked with 81 schools. In all cases, the school established contact with the Extension office, looking for information or assistance in developing a garden, for ongoing guidance in its use, and/or for help with using it

as an outdoor classroom. Sixty-six of the schools established gardens, 64 gardens were used as classrooms or as activity sites, and as of Spring 2010, 54 were still in use. Some gardens were used for specialized topics (science, literacy, leadership) or for special education, but most were not earmarked for any particular subject. Reasons for gardens not surviving varied, including environmental problems such as school renovations and irrigation problems. The loss of a key person (such as a teacher) was occasionally mentioned but lack of support from the principal was cited most often. These results indicate that ongoing communication with teachers and administrators is critical to the sustainability of school gardens.

*Specified Source(s) of Funding:* Cooperative Extension

11:00–11:15 am

### **The Relationship between Levels of Greenery and Landscaping at Track and Field Sites, Anxiety and Sports Performance of Collegiate Track and Field Athletes**

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Researchers wonder what it takes to improve athletic performance in athletes. Research has suggested that plants reduce anxiety, and reduced anxiety could, in turn, improve athletic performance. Research also shows that plants have psychological and restorative value such as improving coping mechanisms in human subjects as well as improving concentration and ability to focus attention that could affect performance of athletes. The main objective of this research was to investigate the impact of greenery/landscaping on athletic performance and cognitive and somatic anxiety in track and field athletes. Four Univ track and field teams and 128 athletes participated in the study. Individual athlete performance and Competitive State Anxiety Inventory-2 cognitive and somatic anxiety tests were collected from 7 track meets. Greenness/landscaping level was determined by Likert-scale rating averages from professional horticulturists who individually rated each site. A regression analysis found that greenness level was a predictor ( $P=0.000$ ) of best performance by athletes when performance level of athletes was the dependent variable and greenness level was the predictor. More of the athletes' best performance marks were at the track and field site that had the highest greenery rating (3.16), and many of the athletes' worst performance marks were achieved at the site that had the lowest greenery rating (1.73). The average norms recorded from all the track and field athletes across the nation were 20.34 for cognitive anxiety and 18.73 for somatic anxiety with mean scores recorded for this study being 22.52 for cognitive anxiety and 26.03 for somatic anxiety. All athletes regardless of event they competed in performed better at sites with higher greenness ratings. All athletes performed similarly at each of the track and field sites regardless of ethnicity, gender or grade classification.

11:15–11:30 am

### **Growing Minds: The Relationship between Parents' Attitudes about Nature and the Development of Fine and Gross Motor Skills in Children**

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Research indicates that adults associate their childhood with playing outdoors, most often in natural settings. Research has found that free play is valuable to child development. Children tend to use outdoor play areas in more physically active ways, and time spent outdoors relates positively to increased physical activity in children. However, children today are spending an increasing amount of time indoors rather than outdoors. Recent research has shown that the amount of time children spend in outdoor play is directly related to parental concerns of their children being exposed to outdoor hazards. The purpose of this project was to investigate the relationship between parents' attitudes toward natural settings and the development of fine and gross motor skills in young children. The sample for this study was drawn from parents of children ages 3–5 enrolled at one of two Univ Child Development Centers. The assessment tool used was composed of sections that ask parents about their attitudes toward nature, about their young children spending time outdoors, how much time their children actually spend in outdoor activities, and standard demographic questions. Data on motor development was collected by the individual child-care centers. Data were entered into and analyzed using SPSS. Statistical comparisons included Pearson product-moment correlations and ANOVA tests. Results from the study will help better develop an understanding of the importance of outdoor play for children, and help horticulturalists justify their product in a time of harsh economic concerns.

11:30–11:45 am

### **Survey of Public Garden Leaders**

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Leadership and leadership development is an important topic facing those who lead and train people in the area of public horticulture. In the Fall of 2007 an email survey consisting of 55 questions was sent to 448 executive directors of public gardens in the United States. This survey was divided into six major sections: demographics on each director's garden and their association with their garden; each directors view of leader-

ship in their garden and in the field of public horticulture; each directors experience with, and their view on the importance of internships; leadership style; each directors level of confidence, and their views on the importance of different aspects of their job; general personal demographic information and each directors' comments. Results from this study suggest current garden directors have an interest in furthering their own knowledge in the area of leadership. The results from this study also revealed leaders of public gardens in the U.S. lead using a participative style of leadership. This style of leadership fosters an environment where subordinates opinions are taken into consideration when making decisions. Respondents to this study also value experiences during college at a high level in regards to choosing their career path. This includes participation in hands-on work experiences such as internships. In conclusion, those who currently lead public gardens typically feel that the ability to communicate is the most important aspect of what they do. Unfortunately, this is also an area where current directors lack personal confidence and desire professional development.

*Specified Source(s) of Funding:* Univ of Tennessee

11:45–12:00 pm

### **Is Gardening Feasible for Inclusion into a Diabetes Intervention Project among a Native American Tribe in Northwest New Mexico?**

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Native Americans experience type-2 diabetes at four times the rate of the general U.S. population. Limited fruit and vegetable intake, poor access to nutritious foods in rural areas, shifts away from traditional diets, and reduced exercise habits are cited as causes for the rise. Poor access to water and limited agronomic information has also been noted by Native Americans residing

in the semi-arid southwest. Garden projects have successfully addressed these issues on a grassroots scale because: 1) gardeners tend to adopt healthier dietary habits by consuming what they produce; 2) parents who garden are more likely to pass this knowledge onto their children; 3) gardening is well received by diabetic individuals as a form of physical activity; 4) gardening offers the potential to raise household income through savings on grocery requirements while providing marketing opportunities to individuals or groups. Yet, little research has been conducted to jointly demonstrate the health, horticultural, and economic benefits of gardening when incorporated into a diabetes intervention project. In 2008, a pre-pilot project was launched in Northwest New Mexico to determine feasibility in developing an intervention strategy using gardening as a means to reduce diet related illness in a predominately Navajo population. The project was divided into two objectives: 1) identify key informants working in tribal, cooperative extension, municipal, Indian Health Services, institutional and educational units dealing with diabetes issues on and near the Navajo Nation; and 2) develop and pilot test culturally appropriate focus group interviews to determine buy-in among Navajo. During focus group sessions, participants were asked questions like: *Is gardening important to you? How do you think that your health could be improved by tending a garden? What problems or barriers do you encounter for farming/gardening in your community? Where might a garden be placed in your community (i.e. is a single community spot at a central space preferred? or is an individual garden at your home preferred?)*. Focus group sessions were moderated by Navajo students who had been trained by project staff. Interviews with key informants suggest the need for greater coordination on the Navajo Nation between public health officials, nutritionists, economists, and horticulturists to avoid duplicative efforts while allowing maximum access to gardens for interested Navajo people seeking to improve their health and income status. Focus group transcripts indicate broad interest to include gardening into diabetes and cancer interventions with the added value of enhancing social capital in Navajo communities.

*Specified Source(s) of Funding:* National Cancer Institute

### **Wednesday, August 4, 2010 Desert Salon 4-6 Oral Session 29: Genetics/ Germplasm/Plant Breeding: Cross-Commodity 1**

3:30–3:45 pm

### **Citrus Genetic Resources of Pakistan and Physiochemical Analysis of Some Potential Cultivars for Diversification of the Citrus Industry**

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The citrus industry of Pakistan is monopolized by Kinnow (*Citrus reticulata* Blanco). It contributes over 70% of the total citrus production. Citrus germplasm plays key role in evolving new high yielding, nutritionally improved and disease resistant varieties for sustainable development and diversification of citrus industry. A study was initiated to document the indigenous and exotic germplasm of existing citrus species/cultivars in Pakistan. Various research centers/institutes of the country (Punjab, NWFP, Sindh, Baluchistan and Federal areas) were visited to collect detailed information of existing citrus species/cultivars. About 210 citrus cultivars were recorded out of which 154 were scion and 56 were rootstocks. Maximum collections of citrus cultivars (210) were recorded in Punjab province followed by Federal areas (80), NWFP (46), Sindh (9) and Baluchistan (8). Among different groups of citrus, 54 cultivars were of Sweet oranges, 28 cultivars of Lemons & Limes, 27 cultivars of mandarins, 15 cultivars of grapefruits, and 27 hybrids were observed along with 56 type of rootstocks and two cultivars of kumquats. Important cultivars of citrus as Sweet Oranges (Succari, Pineapple, Hamlin, Valencia Late, Salustiana, Musambi, Blood Red) Mandarin (Kinnow, Feutrell's Early, Wilking, Freemont, Honey, Fairchild) Grapefruit (Marsh Seedless, Duncan, Shamber) along with Eustis lime were tested for physiochemical properties. Results indicated that among sweet orange cultivars Salustiana produced the heaviest fruit (218.20g) and maximum juice (54.05%). Maximum TSS (11.51°brix) and minimum total titrable acidity (0.2%) was observed in Succari. Among mandarins maximum fruit weight (189.60g) was observed in Kinnow followed by Fairchild, Wilking, Honey, Feutrell's Early and Freemont. Maximum juice (54.90%) and TSS (12.09°brix) was observed in Freemont. Lowest acidity (0.70%) was observed in Feutrell's Early while maximum amount of ascorbic acid (43.37 mg/100 g) was found in Wilking. Among grapefruit cultivars, Marsh Seedless was heaviest with maximum acidity and ascorbic acid. Results showed that the sweet orange cultivars and mandarins other than Kinnow have much higher potential for sustainable industry development in Pakistan. We believe this information

will contribute towards researchers/academicians in understanding citrus genetic resources in Pakistan and their better utilization in the national and international citrus improvement research programmes.

3:45–4:00 pm

**First Steps toward Rescuing Las-infected Citrus Germplasm**

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Huanglongbing (HLB) disease is having a devastating impact on the citrus industry in Florida. The disease is also having significant impact on the USDA citrus breeding program as it has shown up in a number of trees which exist only in our population of segregating hybrids or in a virtually irreplaceable germplasm collection. HLB is associated with infection by *Candidatus Liberibacter asiaticus* (Las) and it is critical that we rescue Las - budwood from elite germplasm that is Las+. Fortunately, Las is known to be unevenly distributed within Las+ trees, and although the pathogen is graft-transmissible, the efficiency of graft transmission never is 100%. Therefore, we reasoned that by selecting budwood that tests Las-, albeit from Las+ trees, we would produce some propagations free of Las. We tested our hypothesis by starting with seven hybrids in our program that exist only in the field and which we felt needed to be rescued. At least 3, and as many as 6, branches from each of these trees were tested for Las using standard qPCR methods. Three propagations were made from each of the Las-tested braches for a total of 90 propagations. Of the braches initially tested, 63% were Las+. Of all the propagations, 89% survived, with no apparent difference in survival between propagations made from Las+ or Las- branches. Of the propagations that survived, Las testing had been completed on 90% of them at the time of this writing. Among all of the propagations that have been tested, 29% were Las+. Among propagations made from branches that were Las+, 55% (18/47) tested Las+ whereas among the propagations made from Las- branches, 12% (3/25) were Las+, with two of these propagations originating from the same original branch. Average Ct value for Las+ propagations from Las+ branches was 27.9 compared to 36.0 for the Las+ propagations from Las- branches; Ct = 36 is accepted as the cutoff between Las- and Las+. So far, our data support the notion that testing for Las prior to propagation is an important first step in the process of rescuing Las- tissue from Las+ trees. Propagated trees will continue to be monitored for the appearance of HLB symptoms and further development of Las as determined by qPCR, to determine whether uneven Las distribution and selected propagation from Las+ trees will permit rescue of critical germplasm.



4:00–4:15 pm

### Screening Antimicrobial Peptides In Vitro for Use in Developing Huanglongbing and Citrus Canker Resistant Transgenic Citrus

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Huanglongbing (HLB, associated with *Candidatus Liberibacter* sp.) and Asiatic citrus canker [ACC, causal organism *Xanthomonas citri* subsp. *citri* (*Xcc*)] seriously threaten the sustainability of the Florida citrus industry. No HLB-resistance has been identified within cultivated citrus, making it a high priority to create transgenic citrus that would permit economic citrus production where HLB is endemic. Little is known about the HLB pathosystem and thus broad spectrum antimicrobial peptides (AMPs) have been the focus for current work, and identification of safe and effective transgenes is essential to our efforts. In vitro assessment of minimum inhibitory concentration (MIC) was conducted using *Sinorhizobium meliloti* and *Agrobacterium tumefaciens* as surrogates for the uncultivable *Liberibacter* as they are closely related alpha proteobacteria. *Xcc* is also a gram negative bacterium and was included in these analyses, in the hope that HLB and ACC resistance can be achieved with the same AMP transgene, if expressed using non-tissue-specific promoters. Nineteen AMPs were initially tested from diverse sources. The most active AMPs included Tachyplesin 1 from horseshoe crab, SMAP-29 from sheep and D4E1 (which is a synthetic AMP derived through evaluation of critical amino acid residues in AMPs, overall peptide structure, and AMP effectiveness). These AMPs inhibited growth of all three test bacterial species at 1  $\mu$ M or less. A further 20 synthetic AMPs were designed based on initial results and seven of these showed effectiveness at 1  $\mu$ M or less across all three test bacteria. Most AMPs were comparable in effectiveness across the three bacterial species, but some species x AMP interactions were observed. Hemolytic activity was assessed by exposure of porcine erythrocytes to a range of AMP concentrations during incubation at 38.5 °C for 30 min. Contrasting hemolysis of AMPs at 10  $\mu$ M revealed that most were not significantly different from water, while melittin (from bee venom) was highly hemolytic as expected. AMPs which suppress bacterial growth at 1  $\mu$ M or less and show negligible hemolysis are the focus for further work, including production of transgenic citrus to express resistance to HLB and ACC.

*Specified Source(s) of Funding:* Florida Dept. of Citrus and USDA/ARS base funding

4:15–4:30 pm

### Enhanced Disease Resistance in Transgenic Grapefruit (*Citrus paradisi*) following Overexpression of Antimicrobial Lytic Peptide Genes

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Florida is the world's third largest producer of citrus, behind Brazil and China. Several diseases, both bacterial and fungal affect this important crop and some like Huanglongbing (HLB) and Citrus canker have the potential to wipe out the entire industry due to the unavailability of resistance in commercial cultivars. Transgenic citrus plants offer the potential to provide resistance to one or more of the diseases affecting citrus. The aim of our current research was to evaluate transgenic grapefruit plants containing either LIMA, CEME or TempA synthetic antimicrobial peptide genes or a natural AttacinE gene from the *Hyalophora cecropia* moth for resistance to either citrus scab, caused by the fungus *Elsinoë fawcetti* or to citrus bacterial spot caused by the bacterium *Xanthomonas alfalfae* subsp. *citrumelonis*. We screened a large population of transgenic lines and isolated several that provided increased resistance to each of these pathogens. Such results are important since randomness of *Agrobacterium* mediated gene integration can lead to considerable variation in the incorporation, position and structure of transgene locus among independent transgenic lines. These factors can subsequently have an effect on the level and stability of transgene expression. Our results enabled us to isolate potential transgenic lines that will subsequently be screened for resistance to HLB and canker.

4:30–4:45 pm

### The Peach Dehydrin Family Is Small Relative to All Other Sequenced Plant Genomes

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Recent advances in genomic sequencing technology have allowed the addition of a number of crops to the growing list of completely sequenced genomes. We have analyzed the peach (*Prunus persica* [L] Batsch) genome of a doubled haploid line ('Lovell 2D') for the dehydrin gene family and compared its members to the genomes of *Arabidopsis*, poplar, apple and rice. This comparison suggests that peach has about half the complement of dehydrin genes found in the other genomes surveyed. Whereas *Arabidopsis* has 10 genes encoding *bona fide* dehydrins, and poplar, apple and rice all have nine dehydrin homologs, peach has only five, identified on the basis of signature sequences, i.e. the K domain, and conserved regions, e.g. the Y domain and the serine tract. Expression analysis of the peach dehydrin genes compared to those in rice and *Arabidopsis* indicates that some functions have been preserved between peach dehydrins and their homologs from other species, while other peach dehydrins have evolved to fill overlapping roles in response to abiotic stress exposure.

*Specified Source(s) of Funding:* USDA, ARS

5:00–5:15 pm

### Phenotypic Diversity of Wild Black Raspberry Germplasm

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Since the 1950s, a lack of genetic diversity in elite black raspberry (*Rubus occidentalis* L.) germplasm has been recognized as a major factor limiting breeding progress. Attempts to incorporate desirable traits from other *Rubus* species have been met with limited success. In 2006, we began an extensive collection and evaluation of wild black raspberry germplasm from across the species' native range. To date, more than 130 wild populations have been sampled from 27 states and two Canadian provinces. These populations show significant variation in a wide range of traits including vigor, plant architecture, thorniness, flowering

and ripening dates, and sensitivity to Verticillium wilt. Some of these traits show regional trends, and will direct where future germplasm collection efforts should focus. Variation in these wild black raspberry populations will be useful for breeding disease resistant cultivars that give growers more options and better meet the needs of the industry.

5:15–5:30 pm

### Progress in Strawberry Breeding at the Univ of Florida: A Historical Variety Trial

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The strawberry breeding program of the Univ of Florida develops varieties that are highly adapted to west-central Florida, where about 8500 acres of strawberries were grown during the 2009–10 season. In order to gain insight into breeding progress over time, three advanced selections and nine released cultivars, from Florida Belle (1975) to Florida Radiance (2008), were compared for various yield and fruit quality traits. Cultivars and selections were arranged in a randomized complete-block design with 10-plant plots as the unit of replication at each of two locations (Balm, FL and Dover, FL). The genotype × location interactions for variables of early (December and January) yield, early average fruit weight, and proportion of cull fruit were highly significant ( $P < 0.01$ ). Gains over time were most striking for important fruit traits such as size and uniformity. Average fruit weight for 'Radiance' was 26.0 g and 21.5 g at Balm and Dover, respectively, compared to 15.4 g and 14.7 g for 'Dover' (1979). Cull fruit in December and January as a proportion of total fruit number for 'Radiance' was 0.08 and 0.20 at the Balm and Dover locations respectively, as opposed to 0.40 and 0.45 for 'Dover'. Other traits including soluble solids content, titrateable acidity, vitamin C content, and taste panel ratings were assessed and will be discussed.

*Specified Source(s) of Funding:* USDA and Florida Agricultural Experiment Station

**Wednesday, August 4, 2010 Springs K & L**  
**Oral Session 30: Plant Biotechnology**

3:30–3:45 pm

**Somatic Embryogenesis and Somatic Embryo Germination of *Camellia azalea* × *Camellia japonica* ‘Maiden of Great Promise’**

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*Camellia azalea* Wei. is a rare and distinct species of the genus *Camellia*. This plant is unique in that it blooms nearly every month of the year. Although this is a highly desirable trait this species is also native to zone 10 and highly difficult to propagate. Additionally, when attempting to hybridize with this species, seed rarely forms. When seeds are produced, they are often under developed and nonviable when sown in vivo. Underdeveloped seeds were collected from mature fruit from the cross *C. azalea* × *C. japonica* ‘Maiden of Great Promise’. Seeds were cultured on MS media containing 10 mg·L<sup>-1</sup> 6-benzylaminopurine (BAP), which triggered the production of primary and secondary somatic embryos. Secondary somatic embryos were cultured on MS media, with 1 mg·L<sup>-1</sup> indol-3-butyric acid and four treatments consisting of 1 mg·L<sup>-1</sup> BAP, 1 mg·L<sup>-1</sup> BAP plus 1 mg·L<sup>-1</sup> GA<sub>3</sub> (GA), 1 mg·L<sup>-1</sup> GA, and no additional hormones (control). All cultures were placed in a growth chamber under constant light and a temperature of 23 °C. Each explant was evaluated for number of secondary somatic embryos formed, number of germinated somatic embryos, and maximum width of the culture. At 12 weeks, the size of cultures in tubes that contained BAP and GA were significantly larger than cultures with just GA or with no added hormone. The average number of somatic embryos per tube increased to 5.9 for culture on media that contained only BAP, 4.3 for cultures with BAP plus GA and 3.0–3.1 for all other cultures. Explants treated with BAP plus GA had the highest number and percentage of germinated embryos 4, 8, and 12 weeks after culture and the number of germinated embryos were significantly higher than all other treatments at 12 weeks. Results indicate that neither BAP nor GA is required for secondary somatic embryogenesis or germination of somatic embryos, which occurred with all treatments. The presence of BAP at 1 mg·L<sup>-1</sup> can increase the rate of explant growth, the number of secondary somatic embryos formed and the number of germinating somatic embryos. Embryo explants cultured on media with BAP plus GA produced the highest number and percentage of germinated embryos, GA alone did not have a significant effect on somatic embryo production or germination but does seem to have a synergistic or additive effect with BAP.

*Specified Source(s) of Funding:* Longwood Gardens

3:45–4:00 pm

**A Preliminary Report on the Use of Embryo Rescue Techniques with Intra- and Interspecific Hybrids in Crape Myrtle (*Lagerstroemia* L.)**

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The flowering shrub or tree, crape myrtle, in the genus *Lagerstroemia* L. is primarily native to tropical regions of Southeastern Asia and Indo-Malaysia. Intra- and interspecific hybrids within the *Lagerstroemia* taxa have resulted in the development of cultivars with improved horticultural characteristics. Combining complementary traits found in the species *L. indica* and *L. speciosa* would appear to have great potential for expanding genetic diversity by improving pest resistance as well as introducing novel floral characteristics. However, male and female sterility observed in the F1 progeny have prevented recombination of genomes of the two species and the inability to introgress genes affecting complex traits such as cold hardiness as a part of a cultivar improvement program. No progress of embryo rescue on crape myrtle has been reported so far. The objective of this study was to get survive plants from backcrosses between the sterile F1 resulting from *L. indica* × *L. speciosa* and *L. indica* cultivars. Six backcrosses (including reciprocal) with three *L. indica* cultivars were attempted in 2009. To prevent the drop of seed capsules and abortion of embryos, a solution containing 5 mg/L 2, 4-D, 100 mg/L AgNO<sub>3</sub>, and one drop of Tween 20 per 500 mL was applied to the floral petals 2 hours after pollination and then every day until the capsule was matured. Ovaries treated this way remained on the plant while those that were untreated fell off the plant in a week. Approximately 30 embryos derived from *L. indica* × *L. indica* crosses have been used as a control to improve techniques and develop new media formulations. We cultured young embryos in vitro on a nutrient medium composed of half strength MS basal salts plus 30 g/L sucrose, 30 g/L glucose, MS vitamins, 3% coconut water, and 6 g/L Agargel. The cultures were incubated at 25 °C with a 16 hr photoperiod. Healthy plants were obtained from most embryos of *L. indica* × *L. indica* crosses. No viable embryos were found in the crosses of F1 hybrid as female, but some crosses where *L. indica* was used as the female produced embryos. Two of these embryos have germinated to produce viable plants. Several clones were duplicated from these two viable plants onto a new growth media before transferring

to an 18-pot tray on a mist bench. The survived plants were transferred to soil and examined for fertility and horticultural traits in greenhouse condition.

*Specified Source(s) of Funding:* no

4:00–4:15 pm

### LD Mapping of Melon Traits

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East European melon varieties are distributed in versions known as adana were grouped under the convar- *europaeus*. Current research is to identify QTLs for various traits through association mapping strategies and cultivars with breeding value using model based predictions. We aim to test LD pattern across the melon genome by using mapped markers from the published literature (Gonzalo et al., 2005 and Fukino et al., 2008), EST based SSRs and AFLPs. A total of 369 alleles amplified by 44 SSR primers and 2938 AFLPs were used in the study. LD (Linkage disequilibrium) was estimated separately for various linkage groups as well as genome-wide markers. LD pattern and extent in melon varies from one linkage group to the other. Our study concluded that there is high LD across the melon genome with reference to Ukrainian collections. We performed association mapping using General Linear Model (GLM) and Mixed Linear Model (MLM) with shared ancestry (Q-matrix for both GLM and MLM and Kinship for MLM alone) using both sets of data (mapped and unmapped) across the five growing seasons (2003–2007) using the program TASSEL 2.1. In the current study, a majority of QTLs showed that they are significant through the multiple years of evaluation. Common markers are identified for fruit yield and soluble solids that can be used for marker assisted selection to simultaneous improve yield and high quality. Seven markers were identified to be linked with the resistance of powdery mildew. This is the first QTL identification study using association mapping approach in melons. Best Linear Unbiased Prediction (BLUP) is a standard method for estimating random effects of a mixed model (Piepho et al., 2008). We used BLUP to predict breeding values of melon collections taking into consideration of QTL genotype X environmental interaction. We conclude that in melon improvement programs, application of mixed models with random genetic effects can be very useful to estimate heritable genetic variance for various traits.

*Specified Source(s) of Funding:* USDA-ARS

4:15–4:30 pm

### DArT Markers for Linkage Mapping and Cross-species Comparison of Genome Structures

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Diversity Arrays Technology (DArT) provides a high throughput, microarray-based marker platform for analysis of plant genomes. The technology is particularly well adapted to cross-species comparative applications. In collaboration with Diversity Arrays Technology, Pty. Ltd., we have developed a DArT array for use with wild *Solanum* species of breeding potential for potato improvement. Comprised of approximately 16,000 elements, the current DArT array is optimized for study of the potato tertiary gene pool, a group of about 18 disease, pest, and stress tolerant species. To date, DArT-linkage maps have been constructed for two species: *S. bulbocastanum* and *S. commersonii*. DArT markers correspond to bacterial clone libraries. Plasmid inserts for more than 500 DArT markers mapped in *S. bulbocastanum* were sequenced. The resulting sequences were aligned to burgeoning tomato and potato whole genome sequences, facilitating comparison of genome structures between tomato, potato, and *S. bulbocastanum*. This analysis allowed assignment of *S. bulbocastanum* linkage groups to specific tomato and potato chromosomes and validates map development procedures for *S. bulbocastanum*. Results to date reveal nearly perfect conservation of marker order across the three species and within each genetic linkage group. However, marker order is disrupted by a limited number of large-scale chromosome rearrangements (e.g. inversions and translocations) associated with species divergence. Our analyses suggest that the genome of *S. bulbocastanum* is more similar in structure to that of potato than tomato, consistent with reported phylogenetic relationships. Additionally, we are evaluating the relationships between physical and genetic distances across species on a genome-wide scale. Understanding similarities and differences in genome structure has implications for the use of wild relatives of crop plants in breeding and gene mapping/cloning. This project was supported by the National Research Initiative of USDA's National Institute of Food and Agriculture.

*Specified Source(s) of Funding:* USDA NIFA

4:30–4:45 pm

### Effect of Explant Type and Plant Growth Regulators on the Micropropagation of *Echinacea purpurea* L.

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*Echinacea purpurea* L. is an indigenous plant of North America and occupies an important place among medicinal plants due to its immunostimulant properties. The increasing demand of high quality plant material has necessitated its true to type, disease-free propagation through tissue culture. Different types of explants and plant growth regulators effect the in vitro regeneration of *Echinacea purpurea* L. In vitro regeneration potential of different types of explants in different types of plant growth substances was investigated in this study. Leaf discs, adventitious root segments and petiole segments were compared for their morphogenic potential in different concentrations and combinations of plant growth regulators. Seeds of *Echinacea purpurea* were grown in magenta boxes containing MS medium under controlled conditions. Explants were excised and cultured under aseptic conditions onto nutritional medium containing Murashige and Skoog (MS) salts and B5 vitamins mix with combinations of 1.0–5  $\mu$ M BAP, 1.0–5.0  $\mu$ M IBA and 0.1–1.0  $\mu$ M TDZ. The cultures were kept in growth cabinet with cool white light (40–60  $\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ) under 16-h photoperiod. Regeneration was quantified at 28 days based on the degree of callogenesis, organogenesis, and somatic embryogenesis. Root segment explants found to be more efficient for their morphogenic ability followed by leaf and petiole explants. Whereas maximum callogenesis was achieved in petiole explant followed by root and leaf explants. An interaction was found between the PGR and explant types. These investigations will aid in the development of a model system for clonal mass propagation and in vitro regeneration of *Echinacea purpurea* L.

*Specified Source(s) of Funding:* 1. Higher Education Commission of Pakistan. 2. Pakistan Agricultural Research Board

4:45–5:00 pm

### In Vitro Regeneration of *Lilium henryi* Baker and Assessment of Genetic Stability in Micropropagated Plants using RAPD and ISSR Techniques

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*Lilium henryi* Baker is a native lily from mountainous regions of central China and has great potential as an ornamental plant for its long-lasting orange flowers and recurved petals. The plant is much more tolerant to lime soil than most *Lilium* species. To effectively conserve and utilize this plant for our future breeding, an efficient micropropagation protocol was established. Explants from bulb scales were disinfected using ethanol/ mercuric chloride and cultured on MS medium with different exogenous plant growth regulators (BA, TDZ and NAA). The better results, multiplication rate of 15 shoots per explants, were obtained in the medium containing 0.5 and 2 mg/L NAA and BA. To detect somaclonal variation among the donor plant and micropropagated plants, random amplified polymorphic DNA (RAPD) markers and inter simple sequence repeat (ISSR) markers were conducted. A total of 35 RAPD primers were used to amplify clones and the donor plant, which yielded zero polymorphic band among 247 scorable bands. Analysis of ISSR using 30 primers produced very lower genetic variations. Only 5 polymorphic bands were generated, which resulted to 1.1% polymorphism. The low percentage of genetic variations indicated that the genetic stability of tissue culture plants for *L. henryi* and the feasibility of this tissue culture system. Dr. Qixiang Zhang is the corresponding author.

*Specified Source(s) of Funding:* National Key Technology R & D Program in Eleventh Five-Year Plan of China (2006BAD13B07) and Found (No:2006-4-C08) from State Forestry Administration of P.R. China

5:00–5:15 pm

### Regeneration of Pear (*Pyrus communis* L.) from Shoot Tip and Nodal Cultures

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In vitro regeneration is a potential tool used for the preservation of superior germplasm and breeding of fruit species. Nodal segments and shoot tips were cultured in different concentrations and combinations of plant growth regulators (PGR) to evaluate the in vitro regeneration potential of pear (*Pyrus communis* L.) cv. Nashpati. Murashige and Skoog (MS) medium was used as basal medium combined with different concentrations and

combinations of NAA and IBA and TDZ. MCL (Cheveau and Leblay Regeneration Medium), CL vitamins, and SPSP (Cheveau and Skirvin Standard Pear Shoot proliferation Medium) was used in these investigations. MS medium (6899: 4.4 g in 1000 mL of dd water) containing IBA and NAA were used for root initiation. Nodal segments and Shoot tips (1 cm) were excised and cultured onto nutrition medium. Cultures were incubated in a growth cabinet at 23 to 25 °C under 2500 lux inflorescent light intensity with a 16-h photoperiod. Nodal segments gave more shoot initiation percentage (88%) in Murashige and Skoog salts containing 2.0 ( $\mu\text{M}$ ) TDZ followed by MS + 0.5 ( $\mu\text{M}$ ) NAA + 2.0 ( $\mu\text{M}$ ) TDZ where 75% shoot initiation was achieved. Shoot tip explant gave 69 and 62 shoot initiation percentage respectively in both the cases. The shoots initiated in first step were transferred to SPSP medium (Cheveau and Skirvin Standard Shoot Proliferation Medium) for shoot proliferation and elongation. Shoots obtained in second step were transferred onto root induction medium i.e. MS + 0.1 ( $\mu\text{M}$ ) NAA + 5.0 ( $\mu\text{M}$ ) IBA and rooted shoots were transferred onto MS (6899: 1.7g) without plant growth regulators for root elongation. After 2 weeks the rooted plants were transferred to small earthen pots containing peat moss without nutrients and were placed in mist unit for acclimatization. Almost all of the plants were acclimatized and survived in field.

*Specified Source(s) of Funding:* Higher Education Commission of Pakistan Pakistan Agricultural Research Board

5:15–5:30 pm

### Genetics and Genomics of Chinese Medicinal Plants *Epimedium* L.

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Medicinal plants have been widely used as natural medicines in China and East Asia for more than 2000 years since the first record in the classical Chinese pharmacopoeia *Shen Nong Ben Cao Jing*. Traditional Chinese medicine, based primarily on plant materials, has also become one of the fastest-growing health-care choices in the Western world. Since most of the Chinese medicines are produced using wild plants, a large number of

medicinal plant species are endangered or endemic in the wild due to overharvesting and habitat deterioration. A genetics and genomics project was initiated to reveal the genetic mechanism of active constituents in *Epimedium* species for the sustainable development of Chinese medicines. Dry leaves of *Epimedium* species have pharmacological effects of promoting sexual behavior, reducing blood pressure, improving anti-inflammation and immunity. First, genetic and phytochemical diversity in natural populations were estimated. Second, the genome composition of *Epimedium* species was characterized, comparing with the model species. Third, genes controlling the biosynthesis of flavonoids in *E. sagittatum* were cloned and gene expression was investigated to identify key genes related to the accumulation of flavonoids. Fourth, molecular markers (EST-SSRs) were developed for molecular breeding, systematics, population genetics, and construction of genetic map. The cultivation of new cultivars and sustainable utilization of Chinese medicinal plants, *Epimedium* species, were discussed for better quality control of raw materials used for Chinese medicines and functional foods.

*Specified Source(s) of Funding:* Chinese Academy of Sciences

### Thursday, August 5, 2010 Springs K & L Oral Session 31: Growth Chambers and Controlled Environments

8:00–8:15 am

### Managing Sweetpotato Vines for Space Reduction and Root Yield in the Greenhouse: Up, Down, and All Around

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Sweetpotato [*Ipomea batatas* (Lam.) L.] is a candidate crop for food production and air revitalization in space life-support systems. A cultivar developed at Tuskegee Univ (TU-82-155) produces large amounts of edible roots high in antioxidants, and the vines have edible leaves and shoots, reducing the inedible plant waste. Research in the NASA Specialized Center of Research and Training in Advanced Life Support (ALS NSCORT) at Purdue has focused on developing cultural strategies to reduce the amount of bench space occupied by sweetpotato vines without inhibiting root yield. Growing strategies included vine pruning, select defoliation, hanging baskets with cascading growth, upwardly guiding vines, eliminating branching and maintaining single vines in different orientations and trained around mesh forms. Root yields from the various techniques will be discussed. Maintenance of single, unbranched vines that can be trained around conical and cylindrical mesh frames was the most successful strategy for reducing area occupied without reducing edible root yield. Effects of container size and different growth media were compared. Smaller root volumes stimulated root production relative to larger root volumes, and

media with high water-holding capability inhibited storage-root growth. This research was supported by NASA: NAG5-12686.

*Specified Source(s) of Funding:* NASA

8:15–8:30 am

### **Anthocyanin Content of Red Leaf Lettuce cv. Firecracker Grown under LEDs Is Enhanced with Ultraviolet Light**

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Future space missions beyond low Earth orbit will expose crew members to higher doses of cosmic radiation than currently received onboard Space Shuttle or the International Space Station. A diet rich in bioactive phytochemicals is a potential radiation countermeasure to both reduce the effective radiation dose and induce in situ repair of radiation damage during these long-duration space missions. It has been shown that light quality can be used to increase the anthocyanin content, and thus, antioxidant value, of the salad crops. A series of experiments were conducted to determine the effect of UV-A (315–400 nm) and UV-B (285–315 nm) on the induction of anthocyanin in *Lactuca sativa* cv. Firecracker (a red loose-leaf type). Lettuce was grown in controlled environment chambers (EGC M-12 or EGC M-36, Environmental Growth Chambers, Chagrin Falls, OH) at 23 °C, 65% RH and 1200  $\mu\text{mol}\cdot\text{mol}^{-1}\text{CO}_2$ . An 18 h light/ 6 hr dark photoperiod was maintained at 300  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ . Three control treatments, red LEDs only (640 nm), 270  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  red (640 nm) / 30  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  blue (440 nm), and 300  $\mu\text{mol}$  triphosphor fluorescent (TPF) were used. UV-A treatments were applied with F8T5/BLB 130V 8W fluorescent lamp (385 nm max). UV-B treatments were applied with F9BX/827/ECO 9W fluorescent lamp. Treatments consisted of application of  $\sim 0.5\text{ W}\cdot\text{m}^{-2}$  UV-A or UV-B either continuously through development, or during 14–21 days. Lettuce was harvested at 21 DAP and dry mass, leaf area, plant height, anthocyanin content and oxygen radical absorbance capacity (ORAC) value determined. The results clearly showed that blue light was required for the induction of anthocyanin formation in Firecracker. This is consistent with previous research with cv. Outredgeous. The addition of UV-A resulted in a slight increase in anthocyanin formation under TFP lamps, but not under red LEDs. The addition of blue (440nm) to the LED treatments induced anthocyanin, but no additional response to UV-A was observed. In marked contrast, all UV-B treatments induced additional anthocyanin formation in the red LED, red + blue LED, and TFP treatments. The addition of UV-B during 14–21 DAP was more effective at inducing pigmentation than continuous exposure. These data suggest the bioprotective and nutraceutical value can be enhanced by selective manage-

ment of UV applications under spectral conditions to optimize plant performance of cropping efficiency.

*Specified Source(s) of Funding:* NASA KSC CTC grant

8:30–8:45 am

### **Evolving a Novel Controlled-environment Gas-exchange System**

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A computer-controlled, open gas-exchange system is being developed to monitor photosynthetic rates of small (0.26 m<sup>2</sup>) crop stands grown under controlled conditions of lighting, CO<sub>2</sub>, and temperature. Tall crops that form closed canopies are sole-source lighted with vertical LED strips that switch on sequentially, and a reflective cuvette ceiling is adjusted to a constant distance above the crop stand as it grows. For overhead lighting of low-profile crops, a horizontal LED bank also is vertically adjustable. Plant growth is observed via a USB webcam while temperature and humidity probes monitor the cuvette environment. Each 0.8 m<sup>3</sup> cuvette contains a recirculating hydroponic system with an external reservoir for solution maintenance. Temperature is maintained independently in both cuvettes by a combination of cuvette heat exchange and thermal control of the walk-in growth room that houses the cuvettes. Carbon dioxide is injected via a mass-flow-control valve into an inlet air stream, and the mixture is humidified before injection into the cuvette(s). Absolute and differential CO<sub>2</sub> analyzers located outside the growth room measure precise inlet and outlet CO<sub>2</sub> concentrations, and a command & control computer calculates, displays, and logs instantaneous photosynthetic and respiratory rates of the crop stand on a growth-area basis ( $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ) throughout the life cycle of the crop. The LED array for close-canopy

overhead lighting is a “smart” lighting system that switches on LEDs located only directly above plant tissue, and measures power and energy expenditures for crop lighting. Near-term investigations with this system will seek combinations of adjustable light parameters (irradiance, red/blue ratio, photoperiod, distribution), CO<sub>2</sub> concentration, and temperature that minimize energy expenditure without compromising productivity at each stage of crop development. Longer-term efforts will automate optimization of crop productivity based upon gas-exchange and energy-consumption rates. This project is sponsored, in part, by NASA grant NNX09AL99G.

*Specified Source(s) of Funding:* NASA

8:45–9:00 am

### Temperature Affects Yield and Flavor of ‘Seascape’ Strawberry

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Strawberry (*Fragaria ×ananassa* L.) grown in controlled environments is a candidate small-fruit crop for space life-support systems. A range of environmental conditions is being tested for effects on fruit yield and quality over long durations. Day-neutral ‘Seascape’ strawberry plants were grown under 10-hour photoperiods in three reach-in growth chambers set to day/night temperatures (°C) of 16°/8°, 18°/10°, or 20°/12°. Plants were grown for 282 days with fruit collection beginning 65 days after planting. Fruit were collected, weighed, and counted, and pH, Brix, and titratable acidity assays were performed. Overall, the warmest two temperature regimes produced the largest number of fruit, but the middle temperatures, 18° days/10° nights, produced the highest fruit fresh weight. Individual berry weights decreased with increasing temperature. Yields oscillated over time, with plants grown under warmer conditions fruiting earlier than those under cooler conditions. Brix averaged 10 for the first half of the harvest period but dropped to 8.4 during the latter half, indicating fruit may become less sweet as plants age. Titratable acidity averaged 0.6 but increased slightly during the middle of the harvest period. The highest-yielding group (18°/10°) had the lowest Brix and highest titratable acidity, indicating that as the duration of production progressed, fruits were slightly more tart and less sweet. Fruit from the coolest treatment had the highest Brix and lowest titratable acidity and were slightly higher in pH than fruit of the other temperature treatments. Interestingly, in a previous experiment when human organoleptic evaluations were performed with fruit developed under the same environmental conditions, human tasters preferred fruit from the coolest temperature treatment, and fruit from the intermediate conditions (18°/10°) were highest yielding but least liked. This research was supported by NASA: NAG5-12686.

*Specified Source(s) of Funding:* NASA

9:00–9:15 am

HORTSCIENCE 45(8) (SUPPLEMENT)—2010 ASHS ANNUAL CONFERENCE—AUGUST 2–5, 2010

### Greenhouse Production of *Jatropha curcas* L.

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Physic nut (*Jatropha curcas* L.) or simply “Jatropha” is a suitable non-food alternative species considered under-utilized and it has been identified as a major source for biodiesel production. Florida’s climate and soil characteristics are ideal for the introduction of this species as an alternative energy crop, with the potential for year-round production. However, research on *Jatropha* is limited and a thorough assessment is needed to understand its biology, cultural practices, and potential yields. Greenhouse production experiments were initiated at the Univ of Florida-Fort Lauderdale REC to develop a cost effective greenhouse production protocol. *Jatropha* seedlings were transplanted into 1-gal containers filled with Promix, coir, or Atlas mix and irrigated every 2, 3, or 4 days with approximately 1 L of water. Osmocote 15N–9P<sub>2</sub>O<sub>5</sub>–12K<sub>2</sub>O was incorporated into each growing substrate prior to transplanting at rates of 471, 335, or 58 g of per cubic foot of substrate. Preliminary results indicate that *Jatropha* seedlings grown in Promix, irrigated every 2 days and fertilized with the 471 g of fertilizer grew better than plants in any of the other treatment combinations. Although *Jatropha* is reported to grow on marginal soils and environments, this study indicates that it responds favorably to more frequent irrigation and higher fertilization rates.

*Specified Source(s) of Funding:* Major advisor’s grant

### Thursday, August 5, 2010 Springs H & I Oral Session 32: Vegetable Crops Management: Cross-Commodity 2

8:00–8:15 am

#### Effects of Storage Condition and Suberization on the Development of Enlarged Lenticel Disorder in Fresh Market Potatoes

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Enlarged or raised lenticel is a physiological disorder affecting



potato (*Solanum tuberosum* L.) periderm and is known to be caused by high humidity conditions or oxygen depletion. The disorder starts off as white proliferated cells in waterlogged soils, with the lenticel eventually sinking or expanding in storage, leaving dark scars on the potato periderm. This greatly affects the marketability of fresh-market potatoes for growers, as skin quality is one of the important characteristics influencing tuber preference by consumers. Suberin deposition into the filling cells has also been linked to the shape of the lenticels. The goal of this research was to evaluate the effects of postharvest temperature/relative humidity (RH) on the development of raised lenticel disorder in fresh market potato tubers. Freshly harvested tubers, of the yellow-fleshed variety 'Fabula', were stored at 13 °C or 20 °C, and low (60 to 70%) or high (85 to 95%) RH. Tubers were stored for 12 days (d) and evaluated each 3 d. Incidence and severity of raised lenticel disorder were rated according to the average size of the lenticels' diameter. The greatest weight loss occurred at 20 °C with low RH, losing an average of  $2.6 \pm 1.1\%$  at 12 d. There was an effect of storage temp/RH on pulp moisture content ( $P > F = 0.0213$ ), with 20 °C, low RH having the lowest pulp and peel moisture content of  $79.6 \pm 0.3\%$  and  $85.6 \pm 1.3\%$ , respectively, by the end of storage. Shriveling of the tubers was observed in those kept at the lower RH. Although there was no significant difference in the incidence of the disorder in the four storage treatments, a higher mean lenticel size was observed on the tubers at the lower RH, at both 13 and 20 °C. Our preliminary results suggest that desiccation of the lenticel cells in storage increases the severity of the disorder. Results on effects of suberization on lenticel size will be presented. This information will provide growers and storage operators more knowledge on conditions that affect the incidence or severity of the disorder during storage.

8:15–8:30 am

### Sensitivity of Three Red Potato Cultivars to Glyphosate Drift

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Field research was conducted at the Northern Plains Potato Grower's Association Research site near Grand Forks, ND to evaluate Red Lasoda, Red Norland, and Sangre response to glyphosate simulated drift that may have occurred to plants at one of three growth stages. Glyphosate was applied at rates one-third, one-sixth, and one-twelfth the standard use rate (0.25, 0.125, and 0.0625 lb ai/A) at the tuber initiation (TI), early tuber bulking (EB), and late tuber bulking stages (LB). Seed pieces (2 oz) were planted on 36-inch rows and 12-inch spacing on 10 June 2009. Plots were 4 rows by 25 ft arranged in a split-block design with cultivar as the main factor and the combination of application timing and herbicide rate as sub-plots with 3 replicates. Glyphosate was applied with a CO<sub>2</sub> pressurized sprayer equipped with 8001XR flat fan nozzles with a spray volume of

5 GPA and a pressure of 35 psi. The first application timing (TI) occurred on 23 July 2009. Extension recommendations were used for cultural practices throughout the year. Red Norland was the most sensitive cultivar to glyphosate. Plants treated with glyphosate at the TI stage or with at least 0.125 lb ai/A glyphosate at the EB stage produced significantly more cull tubers (< 4 oz) compared to the untreated control and reduced marketable yields 37 to 50%. Unfortunately, excessive tuber cracking and russet skinning occurred with most of the tubers in these application timings, further reducing marketable yields. Red LaSoda was the next most sensitive cultivar to glyphosate. Plants treated with 0.25 lb ai/A glyphosate at the TI stage or with at least 0.125 lb ai/A glyphosate at the EB stage produced significantly more cull tubers (< 4 oz) compared to the untreated control and reduced marketable yields 34 to 57%. Excessive tuber cracking and russet skinning was most severe in the EB stage with 70 to 100% rejection of marketable tubers due to visible tuber defects. Sangre was the least sensitive tested cultivar to glyphosate. Plants treated with 0.25 lb ai/A glyphosate at the TI or EB stage produced significantly more cull tubers (< 4 oz) compared to the untreated control and reduced marketable yields 31 to 58%. Excessive tuber cracking and russet skinning was most severe in the EB stage with 30 to 100% rejection of marketable tubers due to visible tuber defects.

*Specified Source(s) of Funding:* NDSU

8:30–8:45 am

### Varietal Performances of Some Modern Potato Varieties on Their Yield Potentialities and Storage Behavior

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The general yield level of vegetables in Bangladesh is very poor because of lack of good seeds, adequate varieties, and adequate soil fertility practices. Potato production has expanded rapidly in Bangladesh in recent years, making it the second most important food crop. By increasing the yield and quality of potatoes by adopting high yielding varieties, and by reducing post-harvest losses adopting adequate postharvest technology and handling systems, the problem of existing acute food shortages might be overcome to a significant extent. The present study focused on yield potentialities and storage behaviour (under farmers condition) of six modern varieties of potato viz., Diamant, Cardinal, Granula, Felsina, Provento and Asterix, was conducted at Domar Foundation Seed Potato Production Farm, BADC, Nilphamari and Laboratory of Crop Science and Technology, Rajshahi Univ, Bangladesh, during the period from Dec. 2008 to Aug. 2009.

Results revealed that there were significant variations among the varieties in different yield attributes and storage behavior of potato tubers. Under the experimental conditions practicing by farmers (farmers conditions) the variety Asterix was found to produce the highest yield of tubers (29.60 t/ha) and highest amount of dry matter content (20.50 %). The final weight retained by edible stored tubers of Asterix was higher (80.21%) compared to those of other varieties at the end of four months (120 days) storage. Under the same condition, Diamant was the second highest yielder (28.33 t/ha) containing higher amount of dry matter (20%) and had good storage ability that retained 69.07% of edible tubers at the end of four months storage. The Felsina was the lowest yielder (25.13 t/ha) with low amount of dry matter (16%) and showed poor storage ability retaining with 55.85% of edible tubers in the same storage conditions. Considering results, Asterix showed better performance in respect of most of the parameters studied for yield potentialities and storage behavior. The variety Asterix may be recommended for commercial cultivation and storage under ordinary storage condition or farmers practice. Diamant ranked second position considering the above circumstances, but showed better performance compared to the rest of the varieties.

*Specified Source(s) of Funding:* Not yet decided

8:45–9:00 am

### **Plastic Mulches Affect Crop Microenvironment, Plant Growth, and Fruit Yield in Bell Pepper (*Capsicum annuum* L.)**

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There are numerous studies on the use of plastic mulches for peppers, although relatively few have focused on the microenvironmental and physiological impacts of plastic mulches on bell pepper. The objectives were to determine the effects of plastic film mulches on root zone temperature (RZT), plant growth, and fruit yield in bell pepper. The study was conducted in Tifton, Ga. in the Fall of 2002 and the spring of 2003 using eight colored plastic mulches. Plastic mulch color influenced the microenvironmental, physiological, and yield responses of bell pepper plants. Plastic film mulches differed in their soil-warming ability, with RZTs in both spring and fall being highest in black mulches and lowest in silver mulches. The percentage of photosynthetically active radiation (PAR) reflected from the mulches was highest in silver mulches and lowest in black mulches. The mean RZT under the plastic mulch decreased with increasing percentages of reflected PAR. Silver mulches had among the highest values of soil water status, although neither soil water content nor soil water potential had relationship with RZT. In the fall season plant growth attributes during the first 28 days after transplanting were among the highest in silver mulches and the lowest in black mulches. Both marketable and total yields were higher on silver mulches and lowest on black mulch in the fall, while they were in general higher on silver with a black strip mulch and

lowest on white and silver mulches in the spring. The reduced plant growth and fruit yields in black mulches during the fall were probably due to the increased RZTs, and thus higher heat accumulation, that resulted in higher plant heat stress conditions compared to silver and white mulches. Fruit yield decreased with mean seasonal RZTs above 27 °C. The optimal RZT for bell pepper fruit yield was calculated to be 26.1 °C.

9:00–9:15 am

### **Response of Two Tomato Varieties to Varying Irrigation Levels**

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This field study was conducted in the inland region of the California Central Coast to compare the impact of five irrigation treatments with 4 field replicates on yield and quality of two organically grown tomato varieties, Early Girl (EG) and Brandy Wine (BW). The five treatments were set as percentages of evapotranspiration (%ET), 100, 75, 50, 25, and 12% ET. Initially, all plots were equally irrigated until pre-bloom stage when the different treatments were imposed. Plots of 12% ET treatment received no further water. EG yields for 12% and 100% ET were not significantly different, while for the same 12%ET irrigation treatment, BW had a 50% drop in economic yield. Fruit size, however, showed more complicated trends. Across irrigation treatments, BW produced 87 to 97% of its fruit in the extra large (XL) category and virtually its entire yield in the combined category of large to XL. At 12% ET treatment, EG produced 20% XL fruit and 69% small fruit. The remaining water treatments resulted in 54–60% of the fruit produced in the combined categories XL and L. Generally there was good red color development in BW fruit as indicated by low Hue values. Red color development was slightly less in fruit from treatments 25 and 12% ET. In contrast, the external color of EG fruit was similar in all irrigation treatments. BW fruit dry matter content (% dry weight) was the same (5.3–5.4%) in fruit from the 50, 75 and 100% ET treatments. It was significantly higher as water input decreased to 25 and 12% ET (5.5 and 5.6%, respectively). Soluble solids followed a similar trend as dry weight, but differences among treatments were relatively small (4.5% at 100%ET to 4.9% at 12%ET). The % dry weight of EG fruit in the 12, 25, and 50% ET treatments was significantly higher (6.0%) than in fruit from the well-watered plots (5.6%). EG soluble solids followed a similar pattern (5.2% at 100%ET to 5.7% average for 50, 25, 12%ET). EG tomatoes were less acidic as irrigation ET decreased (0.44% vs. 0.36% Titratable acidity) while there were no differences in acidity of BW tomatoes (0.37% average T.A.).

*Specified Source(s) of Funding:* USDA Specialty Crops, UC Small Farm Program

9:15–9:30 am

### Rootstock Effects on Tomato Yield and Nutrient Uptake under Greenhouse Conditions

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Grafting technology is considered a unique component in sustainable vegetable production. In addition to managing soil-borne diseases, grafting with interspecific rootstocks is suggested to improve yield in tomato (*Solanum lycopersicum*) production due to enhanced nutrient uptake. Four interspecific tomato rootstocks including 'Beaufort', 'Maxifort', 'Multifort', and 'RST-04-105' were evaluated in a greenhouse study using the determinate tomato cultivar Florida 47 as scion in the absence of soil-borne pathogens. Non-grafted and self-grafted 'Florida 47' were used as controls. Essential nutrients were delivered by a regulated Dosatron fertigation system to tomato plants grown in pots filled with horticultural grade perlite. The results showed that all the rootstocks significantly increased the total and marketable yield of 'Florida 47' compared to non-grafted and self-grafted controls. The marketable yield improvement by 'Beaufort', 'Maxifort' and 'Multifort' was attributed to larger number of fruit per plant, while higher average fruit weight was the contributing factor in tomatoes grafted onto 'RST-04-105'. Self-grafting of 'Florida 47' resulted in similar yield as non-grafted control. Plant tissue analysis indicated the overall enhancement of nutrient absorption as a result of grafting with rootstocks. At the first harvest, total above ground accumulations of N, K, and Ca were significantly higher in the grafted treatments in contrast to the non-grafted and self-grafted controls. Self-grafting did not cause significant changes in plant nutrient contents. The elevated levels of nutrients by using rootstocks were largely related to increased biomass accumulation rather than higher nutrient concentration (on a dry weight basis). Interestingly, the leaf concentration of P was significantly lower in the grafted treatments. The enhanced uptake of Ca was consistent with reduced incidence of blossom end rot in tomato plants grafted onto rootstocks. At the final harvest, the grafted treatment with 'Maxifort' maintained significantly higher contents of N, K, and Ca, while grafted plants with other rootstocks did not differ from the non-grafted control. The potential of interspecific rootstocks for enhancing nutrient uptake and improving tomato yield needs to be further investigated in the field trials in order to provide appropriate recommendations for fertility programs of grafted tomato production.

*Specified Source(s) of Funding:* Univ of Florida IFAS Research Innovation Fund

9:30–9:45 am

### Effect of Operating Pressure, Irrigation Rate and Nitrogen Rate on Drip-irrigated Fresh Market Tomato Nutritional Status and Yields: Implications on Irrigation and Fertilization Management

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Increasing the length of irrigation time by reducing the operating pressure of drip irrigation systems may result in reduced deep percolation and may allow for reduced N fertilizer application rates, thereby reducing the environmental impact of tomato production. The objectives of this study were to determine the effects of reduced drip-irrigation operating pressure (OP, 84 and 42 kPa), N fertilizer rate (100%, 80% and 60% of the recommended 224 kg N/ha rate), and irrigation rates (100% and 75% of the recommended 9,340 L/ha/day/string rate), on fresh market tomato nutritional status and yield. Nitrate-nitrogen concentration in petiole sap of 'Florida 47' tomatoes grown in the Spring of 2008 and 2009 in a raised bed plasticulture system were not affected by treatments in both years and were within the sufficiency ranges at first flower, two-inch fruit and first-harvest growth stages (420-1150, 450-770 and 260-450 mg/L, respectively). Total marketable yields were significantly higher at 42 than at 84 kPa OP (21 vs 17 t/ha respectively;  $P < 0.01$ ) in 2008, but were significantly higher at the 84 kPa OP (48 t/ha vs 44 t/ha at 42 kPa,  $P = 0.05$ ) and 100% nitrogen rate (49 t/ha vs 44 t/ha at 50% and 75% N rate,  $P = 0.04$ ) in 2009. Irrigation rate did not have any significant effect on tomato marketable yields in either years with no interaction between irrigation rate and N or OP treatments. Hence, growing tomatoes at 84 kPa OP, 100% of recommended N rate and 75% of recommended irrigation rate provided the highest marketable yields with least inputs in a drip irrigated plasticulture system. These results suggest that smaller amounts of irrigation water and fertilizers (50% and 75%, respectively, of recommended N and irrigation rates) could be applied when using a low irrigation operating

pressure of 42 kPa for the early part of the tomato crop season. In the later part, as water demands increased, the standard operating pressure of 84 kPa could be used. Changing the irrigation operating pressure offers the grower some flexibility to alter the flow rates to suit the water demands of various growth stages of the crop. Furthermore, it allows irrigation to be applied over an extended length of time which could better match plants' needs for water throughout the day. Such an irrigation strategy could improve water and nutrient use efficiencies and reduce the risks of nutrient leaching.

## Thursday, August 5, 2010 Springs K & L Oral Session 33: Citrus Crops 2

9:30–9:45 am

### Mechanized Trunk-applied Herbicides to Eliminate Huanglongbing-infected Citrus Trees

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Huanglongbing is a serious phloem limited bacterial disease of citrus now present in Florida. The recommended control includes scouting for the disease symptoms 3 to 4 times per year, tree removal as soon as possible and control of the psyllid vector with frequent insecticidal sprays. Currently, infected trees are stumped with a large cutter-tractor, hauled out of the grove and burned. A method to reduce excess travel from removing trees 3 to 4 times per year was sought. Applying herbicides containing imazapur to cuts in the trunk was found to be the best method for killing citrus trees. After several trials, an electro-hydraulic mechanized tree trunk incision clamp system with frame design and sufficient strength was found to allow clamping to the trunk, cutting the trunk and applying the herbicide. The details of these operations and the tree-kill results are presented.

*Specified Source(s) of Funding:* Florida Citrus Production Research Advisory Committee

9:45–10:00 am

### Effects of Plant Growth Regulators on the Fitness of the Asian Citrus Psyllid

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The Asian citrus psyllid (ACP) is an important pest of citrus because it is the vector of Huanglongbing (citrus greening dis-

ease), the most devastating disease known in citrus. This pest feeds and reproduces exclusively on young vegetative growth of citrus trees. We hypothesized that plant growth regulators (PGRs) could be used to reduce vegetative growth of citrus, thus reducing ACP populations. Seedlings of Volkamer lemon were treated with six commercially available PGRs (10 replications each): Embark, Sumagic, Atrimmec, Apogee, Profile and Cycocel. Untreated seedlings served as controls. Seedlings were approximately 30 cm in height at the beginning of the study and were grown in 2.3-l citrapots using a standard soilless potting medium. Ten days after PGR application, a pair of ACP was caged on five seedlings of each treatment using transparent clear acetate cylinder cages (34 x 6.5 cm). The five seedlings from each treatment without ACP were used for vegetative growth measurements. All seedlings were maintained in a greenhouse at 28 C and 70% relative humidity. Over the course of fifteen days, the number of eggs laid on each plant was counted daily. Survival of ACP nymphs to adults was assessed. Adults were collected and weighed to determine adult body weight. Due to severe phytotoxicity no data were collected from Atrimmec-treated plants. Only Sumagic and Apogee significantly reduced total shoot growth. The average number of eggs laid per plant was reduced by 85% on Embark and Sumagic-treated plants, and by 65% on Apogee and Profile-treated plants. In contrast, the number of eggs laid increased by almost 40% on Cycocel-treated plants. Survival of nymphs to adults was also significantly affected by PGR treatment. Survival was lowest for plants treated with Profile (7%), followed by Sumagic (36%), untreated control plants (45%) and Apogee (47%). The highest survival rates were observed on Cycocel (72%) and Embark (68%) treated plants. ACP adults that matured on seedlings treated with Sumagic weighed significantly less than those from Embark, Apogee, Profile and control plants, but were similar in weight to those from Cycocel-treated plants. These data indicate that the PGRs tested significantly effected the overall fitness of the ACP; however, contrary to our hypothesis, these effects were observed even in the absence of significant growth reduction. This indicates that the PGRs are affecting ACP fitness through plant biochemical changes, direct toxicity or some other undetermined mechanism.

*Specified Source(s) of Funding:* Florida Citrus Production Research Advisory Council

10:00–10:15 am

### Soil Incorporation of Fungicides in Relation to Leaf Age, Tree Vigor, and Production of 'Blood Red' Sweet Orange

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Different fungicides as soil incorporation were tested to improve leaf age, tree vigor and production of 'Blood Red' sweet orange by correcting health. The experiment was performed on 13- to 14-year-old sweet orange (*Citrus sinensis* Osbeck L. cv. Blood Red) trees grafted on rough lemon (*Citrus jambhiri* Lush.) rootstock, growing at Sq. No. 9 Experimental Fruit Garden, Institute of Horticultural Sciences, Univ of Agriculture, Faisalabad (latitude 31°26'N and longitude 73°06'E) Province, Punjab, Pakistan. Two commercial fungicides, Alliette and Ridomil Gold MZ and CuSO<sub>4</sub>, were used alone, and in different combinations with each other. The experiment was laid out in randomized complete-block design (RCBD) with seven treatments including control with three replications. A single tree was taken as treatment unit, hence data were collected from 21 trees. The experiment was performed for 2 years and a lot of data on different parameters of vegetative and reproductive growth were recorded. Leaf retention, total number of buds/ shoot and production were significantly improved compared with control. Soil drenching of Ridimil Gold MZ along with CuSO<sub>4</sub> remained the best treatment. It was revealed from these 2-year studies that for such a field experiment, so short a period was insufficient to get concrete results for fungicide applications. General health and vigor was improved, which was attributed to better uptake of nutrients by improved health of diseased roots of the trees. Further it was evident from the results that best management practices (BMP) could improve the production of sweet oranges in Pakistan for diversification of monoculture citrus industry of Punjab Pakistan.

*Specified Source(s) of Funding:* Punjab Agriculture Research Board (PARB) Pakistan

10:15–10:30 am

### **Serology, Transmission, and Protein Analysis for Diagnosis of Citrus Tristeza Closterovirus in the Punjab, Pakistan**

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Fifty samples of each of sweet orange (Malta and Mosambi), kinnow mandarin and grapefruit collected from five locations of the Punjab (2007–08) were analysed through DAS-ELISA for the diagnosis of CTV, using polyclonal antibodies. On the basis of ELISA positive reaction, incidence of CTV in the locations ranged from 20–45% with the mean of 32% infection. The high number of ELISA positive samples were found at Bhalwal with mean OD<sub>260</sub> nm (0.46), followed by samples at Sahiwal (0.29), Faisalabad (0.24), Toba Tek Singh and Sargodha (0.17). Polypeptide profile was analysed through SDS-PAGE for the leaf and bark protein of citrus samples but no significant changes were found except slight alteration in the electrophoresed protein in sweet orange. Symptoms of mild leaf flecking were produced in acid lime after mechanical inoculation of sap from infected sweet orange, but aphid transmission using *Aphis gossypii* and whitefly was not successful. Therefore, insect transmission of CTV constitutes the subject of future investigations.

10:30–10:45 am

### **Foliar Application of Boron and Zinc Influence the Vegetative and Reproductive Growth, Yield, and Fruit Quality of *Citrus reticulata* Blanco cv. Kinnow**

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Among the micronutrients, B and Zn play very vital role in the nutrition of citrus. To study the influence of foliar application of boron and zinc (as boric acid and zinc sulphate) on the tree growth and fruit quality of *Citrus reticulata* Blanco cv. 'Kinnow

now', two separate experiments were conducted. In the first experiment, boric acid at the rate of 0, 0.1%, 0.2%, 0.3%, and 0.4%, and in the second experiment, zinc sulphate at the rate of 0, 0.2%, 0.4%, 0.6%, and 0.8% were sprayed after fruit setting stage to the nine year old Kinnow mandarin trees budded on Rough Lemon (*Citrus jambhiri* L.) root stock. Foliar application of boric acid (0.3%) significantly increased the leaf N, P, Ca and Mn levels, while leaf K and Zn levels were highest with 0.2% boric acid application as compared to other treatments. The trees sprayed with 0.4% boric acid showed highest leaf B contents in Kinnow mandarin leaves. Tree height and flush length; fruit yield; fruit titratable acidity, ascorbic acid, total sugars and non-reducing sugars were highest when trees were sprayed with 0.3% boric acid in contrast to other treatments. In the second experiment, foliar application of 0.2% zinc sulphate showed highest increase in N and Ca levels in Kinnow mandarin leaves, while trees sprayed with 0.6% and 0.8% zinc sulphate exhibited higher level of P and K, respectively. Maximum leaf Zn, Fe and Mn concentrations were observed in trees sprayed with 0.8%, 0.6% and 0.2% zinc sulphate in the Kinnow mandarin leaves respectively as compared to other treatments. Tree height and tree spread was significantly increased with 0.6% zinc sulphate sprays, whilst lowest fruit drop and highest yield was obtained from trees treated with 0.4% zinc sulphate as compared to control. Similarly, foliar application of zinc sulphate also improved the fruit quality in terms of total soluble solids, total sugars, ascorbic acid contents than untreated trees. In conclusion, foliar applications of B and Zn can be used effectively to improve the leaf mineral status, yield and fruit quality of Kinnow mandarin.

*Specified Source(s) of Funding:* PARB

10:45–11:00 am

### **Progress using Biotechnological Approaches to Improve the Disease Resistance of Commercial Citrus**

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The 9 billion dollar/year Florida citrus industry is now under siege by two important diseases - citrus greening, also known as huanglongbing (HLB), and citrus canker. Both these diseases are caused by gram negative bacteria. Canker is primarily affecting the grapefruit industry and poses problems with the establishment of new sweet orange groves. It can be managed by following a canker suppression program, whereas HLB affects all cultivated citrus varieties and cannot currently be controlled. Resistance to either HLB or canker is also not present in commercial orange and grapefruit cultivars.

A non-GMO biotechnology-based strategy for the development of canker resistant grapefruit is to transfer the cytoplasm of kumquat (believed to contain a gene(s) for canker resistance) to grapefruit by the process of somatic cybridization. Cybrid citrus plants can be produced as a by-product of somatic fusion. Putative cybrid grapefruit plants from several commercial cultivars containing kumquat cytoplasm have been produced and are being characterized. Some of these plants are showing significantly improved canker resistance in a detached leaf assay. Progress with this work will be presented. Another primary strategy is to develop resistant cultivars via genetic engineering by incorporating resistance genes not found in citrus. We have successfully cloned several natural and synthetic antibacterial genes and genes that have the potential to turn on SAR (Systemic Acquired Resistance) and made significant progress in introducing them into commercial sweet orange and grapefruit cultivars. We have regenerated hundreds of transgenic citrus plants, using both the standard Agrobacterium-mediated transformation system and the protoplast/GFP transformation system developed previously in our program. Genetic constructs containing promoters that target expression of the above gene(s) exclusively to the phloem tissue, where HLB resides, are also being utilized in efforts to minimize foreign gene expression in fruit or juice subsequently going to market. Progress towards the development and testing (greenhouse and field) of such transgenic disease resistance in commercial citrus cultivars will be discussed.

### **Thursday, August 5, 2010 Springs H & I Oral Session 34: Pomology: Fruit & Nut Crops**

10:00–10:15 am

#### **Fruit Set Failure and Low Production of Deciduous Fruit Trees Grown under Warm Climate Districts**

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Trees of pome fruits (apple, pear, and quince) and stone fruits (apricot, peach, plum, and cherry) grown under warm winter areas face some problems causing low or limited fruit production. Such problems are: late leaf defoliation, insufficient chilling requirements, bad cultural practices, misusing of breaking dormancy agents and self incompatibility in some cultivars. Such problems and their solutions will be discussed. The following solution will be reviewed and clarified: Breaking seed dormancy of deciduous rootstocks, select suitable low chilling requirement cultivars, applications of leaf defoliation agents, suitable cultural practices (Correct training and pruning – Suitable Irrigation system) and recommended timing and concentrations of dormancy breaking agents.

*Specified Source(s) of Funding:* work

10:15–10:30 am

### **Nutrient Budgeting under Four Groundcover Management Systems (GMSS) in an Apple Orchard**

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Overuse of nitrogen fertilizers can pollute surface and ground water, and high leaching losses may occur when nitrogen (N) fertilizer rates are not adjusted to crop demand and N availability in soil. Quantifying nutrient inputs and outputs from orchards is a useful tool to optimize nutrient supply, especially for N. We conducted an experiment near Ithaca, NY, to develop N budgets based on the N dynamics under four groundcover management systems (GMSs), with and without N fertilization. Three replications of four GMS treatments were randomly assigned to 12 plots and have been maintained since 1992 in 2-m-wide strips within tree rows: Pre-emergence residual herbicide (PreHerb), post-emergence herbicide (PostHerb), mowed-sod (Sod), and hardwood bark mulch (Mulch). We measured N inputs to the system (N fertilizer, rain and irrigation water), N outputs (harvested fruit, surface runoff and subsurface leaching), and internal fluxes of N (recycling groundcover vegetation, soil mineralization, leaf litter fall and pruned wood). The overall balance for N among GMS treatments for the year with N fertilizer additions was positive, and was greater in the PostHerb and Mulch treatments. In the year without fertilizer, the overall balance for N was negative for the PreHerb and PostHerb treatments, but positive for the Mulch and Sod treatments. Soil mineralization and recycling groundcover biomass accounted for more than 60% of total internal N fluxes in both years, and harvested fruit represented over 80% of N outputs from the system. During the year with N fertilizer additions, N losses averaged 1-2% from surface runoff, and 15-18% from subsurface leaching among the four GMSs. In the year without fertilizer N, surface runoff N losses were twice as great as subsurface N leaching losses from the orchard.

10:30–10:45 am

### **Preconditioning and Fruit Maturity Interactions on Soft Scald and Soggy Breakdown of 'Honeycrisp' Apples**

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'Honeycrisp' apples were harvested at starch indices of 2 to 4 and 5 to 7 from two orchards in 2008 and 2009. Fruit were harvested on two different dates to get fruit at different stages of maturity in 2008. In 2009, ethephon was applied to trees to get fruit at two different stages of maturity on the same date.

Fruit were preconditioned at 16 to 22 °C for 7 days and then put in cold storage at 1 °C with unconditioned fruit until Dec. 2008 or Jan. 2009. With the early stage of maturity in 2008, preconditioning did not reduce soft scald incidence (SSI) which was 22% in fruit from Orchard 1 and 2% from Orchard 2. SSI in fruit from Orchard 1 with the later fruit maturity was 35% and this was reduced to 1% by preconditioning. SSI remained low in fruit from Orchard 2 with the later maturity. In 2008, soggy breakdown incidence (SBI) was 2% in the unconditioned fruit and was increased to 16% by preconditioning with fruit at the earlier stage of maturity with both orchards. With later maturity, SBI was similarly increased by preconditioning in fruit from Orchard 2, but not with Orchard 1 which had very low incidence, <1%. In 2009, very little soft scald or soggy breakdown, <2%, occurred with either stage of maturity in unconditioned fruit. SSI and SBI were increased to 8% and 5% respectively, by preconditioning fruit at the earlier stage of maturity, but not the later stage and only in fruit from Orchard 1. SSI and SBI in fruit from Orchard 2 was unaffected by preconditioning. In some cases, preconditioning 'Honeycrisp' apples at an early stage of maturity increased incidence of soft scald and soggy breakdown.

10:45–11:00 am

### **Long-term Effects of Tree Density and Tree Shape on Apple Orchard Performance**

Terence Lee Robinson\*

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A replicated field trial planted in 1997 compared 8 tree densities (range 598-5382 trees/ha) and two tree shapes (conic and V) with 4 apple cultivars ('Gala', 'McIntosh', 'Empire', and 'Fuji') for 13 years. At the lowest density (598 trees/ha), trees were planted on M.7 rootstock and at the second lowest density (840 trees/ha) trees were planted on M.26 rootstock. At all the 6 higher densities, trees were planted on M.9 rootstock. After 13 years, there was a strong negative effect of tree planting density on trunk cross-sectional area. Among M.9 treatments, the highest planting density produced trees about 1/2 the size of the lowest planting density. Tree density was negatively related to cumulative yield per tree, but was positively related to yield per hectare. The cumulative yield per hectare of the highest tree density was 2 times greater than the lowest density. However, tree shape interacted with tree density. At the highest densities the conic shaped trees had the highest cumulative yield while at the lower densities the V shaped trees had the highest yield. Tree density was positively related to canopy light interception from year 2 through 12. The highest tree density achieved 70% canopy light interception by year 7. Cumulative yield was a function of light intercepted. However, there was a significant interaction with tree shape. The V shape intercepted more light, but at high tree densities it had lower yield than the conic shaped trees. Tree density was negatively related to yield efficiency based on light interception or trunk cross-sectional area. Fruit color was negatively related to tree density. However, cumulative crop value based on both yield, fruit size and fruit color was positively related to tree density for both the conic and the V shapes.

11:00–11:15 am

**New “Fruiting Wall” Canopy Architectures and Training Systems for Sweet Cherries**

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Highly-structured canopy training systems for sweet cherries are not new (e.g., Marchand Drapeau, Tatura trellis), but previously these have not been adopted widely. During the past decade, the commercial availability of precocious hybrid rootstocks that also confer varying levels of tree size control have stimulated the development of several unique training systems having the objective of establishing a highly-structured, continuous narrow vertical canopy or “fruiting wall”. The first precocious fruiting wall research in North America (G. Lang) used radical orientation of tree leaders and selective bud removal to create trellised, bi-lateral cordon canopies similar to the lyre system for grapevines. This has evolved into the unilateral “Upright Fruiting Offshoots” (UFO) high density system (M. Whiting) that provides uniform, renewable fruiting units (comprised of spur and non-spur fruiting sites) that simplify canopy and crop load management, and increase the potential for some orchard mechanization and improved labor efficiencies. Recent research at MSU on UFO tree spacing, trunk angles, and upright shoot formation strategies will be discussed. A second fruiting wall strategy is evolving in Italy, the super slender axe (SSA) or uni-baum ultra high density planting system (S. Musacchi). Rather than creating renewable mixed (spur and non-spur) fruiting units, this system promotes the exclusive renewal of non-spur fruiting sites via “short pruning”, an annual renewal of all shoots by retaining only basal non-spur flower buds plus 1 to 3 vegetative buds. Recent research at MSU testing the SSA system also will be discussed. A third fruiting wall system originating in France (G. Charlot) is focused less on uniform shoot renewal than on mechanical hedging prior to harvest. Although not under test at MSU, this system also will be discussed with regard to canopy fruit-leaf physiological relationships compared to the other two systems. Furthermore, scientists from the NC140 regional research project recently established coordinated sweet cherry trials across North America to broadly examine 3 promising high density training systems, including two fruiting wall canopies (UFO and Tall Spindle Axe), each on 3 precocious rootstocks (Gisela 3, 5, and 6). These include 9 sites in the United States (CA, OR, WA, MI, IN, IL, OH, NY, CO), 2 sites in Canada (BC, NS), and 1 site in Mexico (Chihuahua). The potential impacts of fruiting wall canopy architectures are extensive, ranging from more uniform light distribution, easier crop load-leaf area management, increased labor efficiency, more uniform spray coverage, and more feasible orchard covering systems.

11:15–11:30 am

**Foliar Fertilization as an Alternative to Hand-thinning Fruit in Chlorate-treated *Dimocarpus longan* Lour. Trees in Hawaii**

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Longan, *Dimocarpus longan* Lour, is a member of the Sapindaceae, a family that also includes lychee, and rambutan. The discovery of potassium chlorate (KClO<sub>3</sub>) induced flowering solved the problem of alternate bearing and enabled the grower to produce off-season longan. Chlorate treatments commonly induces flowering in 90% to 100% of the terminals which require fruit thinning when fruits are 6–12 mm. Fruit thinning is a very labor intensive process consisting of the removal of 1/2 to 2/3 of each panicle. Here we describe a comparison of sequential applications of foliar fertilization during fruit development with hand thinning of fruiting panicles on two longan cultivars, ‘Egami’ and ‘Biew Kiew’. Preliminary results suggest that foliar fertilization was comparable to hand thinned fruiting panicles in a low-bearing fruit cultivar such as ‘Biew Kiew’ longan. However, in a heavier bearing cultivar such as ‘Egami’, there was a greater incidence of fruit cracking and unmarketable under-sized fruits in the foliar fertilized trees. Differences in titratable acids, peel thickness, aril firmness, disease incidence and postharvest quality were also observed between the foliar fertilized and the hand thinned fruiting panicles.

*Specified Source(s) of Funding:* USDA-CSREES

11:30–11:45 am

**Response of Pecan Yield, Quality, and Return Bloom to Water Stress during Three Fruit Development Stages**

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Pecan production in the western US requires regular irrigation to maintain yield and profitability. Mature 'Western' cultivar pecan trees in a flood-irrigated orchard in southern New Mexico were evaluated for their response to water stress during fruit development stages. In 2008 and 2009, trees were subjected to three treatments: 1) early season water stress (ES)—two nonconsecutive irrigations skipped during pollination, fruit set, and fruit expansion stages (May to mid-July); 2) mid-season water stress (MS)—two nonconsecutive irrigations skipped during liquid endosperm and shell-hardening stages (mid-July through August); and 3) late season water stress (LS)—two nonconsecutive irrigations skipped during the kernel filling stage (September to late October). The control (C) was fully irrigated (16 irrigations in 2008 and 18 irrigations in 2009) according to the Mesilla Valley Pecan Growers' Irrigation Scheduling Estimator, a model based on historic climate data. Morning stomatal conductance (between 8 AM and noon) and midday stem water potential (between noon and 4 PM) were measured 1 day before and 2 days after each irrigation. Soil moisture was measured at 0.3 m and 0.9 m depths. Yield was measured for each tree, and nut quality parameters (adherent shucks, nuts per kg, percent kernel, and percent blank nuts) were evaluated for a representative sub-sample of nuts from each tree. Return bloom was measured on randomly selected shoots in the spring. Relative to C, the combined 2008 and 2009 yield was 17% lower for ES and 26% lower for MS. There was no difference in the combined yields between C and LS. There were no obvious effects of water stress on nut quality in 2008. Although return bloom was not affected by MS and LS, the return bloom was lower for ES than for C in 2009. This experiment is a starting point for the development of a regulated deficit irrigation strategy for growing pecans in the western United States. *Specified Source(s) of Funding:* Rio Grande Basin Initiative, USDA-ARS/NMSU Specific Cooperative Agreement for Pecan Research

Thursday, August 5, 2010 Springs D &amp; E

## Oral Session 35: Organic Horticulture

10:15–10:30 am

### Influence of Compost Amendment and Tillage Method on Nutritional Quality of Organically Grown Broccoli and Lettuce

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The potential of organic production for enhancing health-promoting antioxidant phytochemicals in fruits and vegetables as compared to their conventional counterparts has been demonstrated in recent studies. Moreover, it is suggested that even within organic systems different management practices may result in distinctly different impacts. An experiment was carried out in Fall 2009 to assess the nutritional quality attributes of broccoli and romaine lettuce grown using different organic amendment and tillage methods. Broccoli and lettuce plants were grown in certified organically managed field plots at Puyallup established since 2003. A split plot design with 4 replications was employed involving tillage (conventional plow vs. till with spader) as the whole plot factor and amendment (low C:N composted broiler litter applied preplant at 2 dry tons/acre vs. medium C:N on-farm compost applied preplant at 8 dry tons/acre) as the subplot factor. Lettuce was cultivated as a double crop with the first and second plantings harvested on 6 July and 21 Aug., respectively, while broccoli was harvested on 23 July. Yields of broccoli and lettuce were not significantly influenced by the tillage method, whereas composted broiler litter resulted in a significant increase in yield of broccoli, in contrast to the on-farm compost. Vitamin C, total carotenoids, total phenolics, and antioxidant capacity measured by Oxygen Radical Absorbance Capacity (ORAC) assay were measured in harvested broccoli and lettuce samples that were frozen and sent to Gainesville for analysis. The two organic amendments resulted in similar levels of phytochemicals and hydrophilic ORAC values in both broccoli and lettuce, whereas tillage method showed prominent effects on the levels of total carotenoids and phenolics and hydrophilic ORAC values depending upon the crop and harvest. In contrast to conventional tillage, the spade tillage method reduced significantly the concentrations of carotenoids in broccoli. With respect to lettuce, decrease of total phenolic content and antioxidant capacity in the spade till treatment was observed in samples from the first and second harvest, respectively. With the increasing interest in conservation tillage for organic vegetable production, more in-depth research is warranted to elucidate the impact of tillage methods on crop productivity and produce quality as well as the underlying mechanisms.

10:30–10:45 am

### Integrated Systems of Weed Management in Organic 'Vidalia'® Onion

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Trials were conducted in southeastern Georgia to develop integrated systems of weed management in organic Vidalia® onion. Treatments were a factorial arrangement of summer solarization, cultivation, and herbicides appropriate for use in certified organic production systems. Plots were solarized with clear plastic during the summer months prior to transplanting onion, with the mulch removed in October. Cultivation treatments used a tine weeder, with cultivation twice at 2-week intervals, four times at 2-week intervals, and non-cultivated. Herbicides were clove oil plus vinegar, clove oil plus a petroleum oil insecticide used as an adjuvant, and a non-treated control. Onion were transplanted in December of 2007 and 2008, with cultivation and herbicide application events occurring the following January and February both seasons. Onion were harvested and graded in April each year. Sub-samples of onion bulbs were collected from each plot and stored in a controlled atmosphere storage facility at the Univ of Georgia Tifton Campus. After 120 days, the sub-samples were rated for fungal and bacterial diseases that developed during storage. Weeds present in the trials were cutleaf eveningprimrose and swinecress. Preplant solarization during the previous summer did not control the cool-season weeds present in these trials, along with no effect on onion yield. It is theorized that dormant, cool-season weed seed are immune from solarization during the previous summer. Cultivation with a tine weeder twice at 2-week intervals was equally effective in controlling cutleaf eveningprimrose and swinecress as four cultivations, with both cultivation regimes increasing onion yield compared to the non-cultivated control. Cultivation with a tine weeder neither damaged nor bruised onion bulbs sufficiently to increase incidence of diseases in stored onion. Clove oil herbicide treatments provided minimal weed control and had no effect on onion yield. Previous experience with clove oil showed contact activity on warm-season dicot weeds, under summer conditions. This was not the case with cool-season weeds under winter conditions, despite efforts to apply the clove oil herbicide treatments during periods of mild temperature in January and February. These data show that cultivation with a tine weeder effectively controlled weeds in transplanted onion and protected yield without the need for handweeding. Cultivation with the tine weeder did not damage the onion bulbs and there was no increase in diseases of stored onion. Cultivation with a tine weeder can be immediately adapted by organic growers for use in transplanted onion.

10:45–11:00 am

### **Developing Nitrogen Management Strategies for Organic Strawberries in the Central Coast of California**

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Nitrogen management in organic strawberries in central coastal California is challenging due to winter rains typically occurring soon after transplanting, unpredictability of N mineralization, the long growth period of strawberries, and the high cost of organic fertilizers. To develop a nitrogen management strategy that is simultaneously productive, reduces environmental impacts, and is cost effective, replicated on-farm experiments using cv. Seascape were conducted in Watsonville, CA for four seasons. Split plot randomized design trials, with supplemental N rates (suppl.) as biweekly applications of liquid organic fertilizer from Mar. to Oct. as main plots and varied pre-plant applications (pre.) as sub plots, were conducted in fields with various organic management histories and soil types. Every year levels of treatments were decided through discussions among growers and researchers. Treatments were: 1<sup>st</sup> season (2005–06); suppl.: 56, 112, and 168 kg-N/ha, pre.: none, feather meal 56 kg-N/ha, and compost 11 Mg/ha, 2<sup>nd</sup> season (2006–07); suppl.: 84, 168, 252 kg-N/ha, pre.: none, Sudan grass, and compost 22 Mg/ha, and 3<sup>rd</sup> and 4<sup>th</sup> seasons (2007–08, 2008–09); suppl.: 0, 168, and 337 kg-N/ha, pre.: 0, 84, and 168 kg-N/ha using blood meal. Marketable and cull fruit yield was monitored weekly from Apr. to Oct. Soil inorganic N in 0–30 cm depth (monthly) and N uptake by strawberry plants and fruits (bimonthly) were determined from Nov. to Oct., from which apparent N-loss during the winter (N-loss) was estimated. To evaluate tissue tests for organic strawberries, NO<sub>3</sub>-N in petioles and TN in leaf blade were monitored monthly from Feb. to Oct. Cost effectiveness of N application schemes was evaluated based on fruit yield and price of fertilizers used. Overall, for pre-plant application, Sudan grass cover crop, compost 11 to 22 Mg/ha, or organic fertilizers up to 84 kg-N/ha worked well. 168 kg-N/ha of blood meal was ineffective especially under rainy winter causing greater N loss. For supplemental N, 112–168 kg-N/ha was found to be appropriate. 337 kg-N suppl. was effective only when pre-plant N was lost by winter rain. In contrast,

supplemental N was ineffective at any rate during a warm-dry winter in a silty clay field with >20 yrs. of organic management. Amount of N-loss varied in a range of -42 to 121 kg-N/ha depending on residual inorganic N level in soil, amount of winter rain, pre-plant N rate, and soil type. Soil inorganic N and petiole nitrate look promising as tools for N management in organic strawberries.

*Specified Source(s) of Funding:* USDA-OREI

11:00–11:15 am

### **Impact of Cover Crops and Organic Amendments on Soil Microbial Activity (SMA) and Tomato Yield under Organic Production Systems**

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Soil fertility under organic production systems is largely managed through use of cover crops and organic amendments, mainly compost. Apart from adding nutrients, one of the key processes facilitated by cover crops and organic amendments is stimulation of SMA. Soil microorganisms are directly implicated in the breakdown of complex nutrient molecules/forms which can then be readily taken up by plants. Therefore, SMA parameters (biomass, respiration, metabolic quotient etc.) have the potential for use as diagnostic indicators of soil quality. This study seeks to better understand how cover crops and compost application affect SMA under organic tomato production system. Cover crop treatments were cereal rye (*Secale cereale* L.) alone and a combination of rye and hairy vetch (*Vicia villosa* Roth.). Each cover crop treatment was used either alone or in combination with compost in a split-plot arrangement. Cereal rye was drilled at the rate of 78 kg·ha<sup>-1</sup> in rye only treatment and 34 kg·ha<sup>-1</sup> in rye-vetch treatment. Hairy vetch was seeded at the rate of 25 kg·ha<sup>-1</sup>. Compost was applied at the rate of 20 t·ha<sup>-1</sup>. In 2007, highest soil microbial biomass (SMB, 231.4 μg-C/g soil) was recorded for rye-compost treatment. This can be explained by the dense root system and total biomass production of cereal rye. There was a positive relationship between root biomass and SMB. Addition of compost significantly increased SMB for rye treatment however; such an increase was not found for rye-vetch treatment. Soil respiration (μg CO<sub>2</sub> evolved/g of soil) was also highest for the rye-compost treatment. Rye-vetch treatment, without compost, had the lowest soil respiration value (140.3 μg CO<sub>2</sub>/g of soil). Soil metabolic quotients for treatments ranged from 0.74 to 1.09 but were not statistically significant. Similar trends were observed in 2008. The effect of compost on marketable yield of tomato was significant in both years. Rye-vetch-compost treatment produced highest marketable yields (5.2 kg fruit/plant) in 2008. There wasn't a marked difference in yield between cover crop treatments (rye alone and rye-vetch) indicating that both approaches can be adopted; however, the

decision will largely depend on prevailing seed prices. Clearly, there is a positive relationship between compost application, SMB and marketable yields. Enhancement of soil quality through incorporation of cover crops and compost is a viable option for organic systems as it not only enhances soil organic matter but simultaneously increase SMA. Such soils would remain healthy and contribute towards sustainable future yields.

*Specified Source(s) of Funding:* USDA grant # 2005-51300-02391 S4160.

11:15–11:30 am

### **Residue Quality and Decomposition Rate of Terminated Sunn Hemp Grown for Seed**

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The tropical legume sunn hemp (*Crotalaria juncea* L.) is primarily used a summer cover crop in southeastern vegetable crop production systems. Farmers value sunn hemp for its many benefits to the farming system including rapid growth, high biomass yield, efficient nitrogen (N) fixation, and weed and nematode suppression. Seed is imported from production areas in southern Africa at a cost of \$7.00–9.00/kg. Cultivars available for purchase are predominantly short-day varieties and consequently fail to produce adequate seed in the normal period of summer cover crop production (6–8 weeks in Florida). The effects of cultural practices used to manipulate floral initiation and seed production have not been fully examined on biomass production, N sequestration and N mineralization. A 2-year field trial was conducted in the Organic Unit at the UF-IFAS Plant Science Research and Education Unit in Citra, FL to ascertain if managing sunn hemp for seed production would provide additional N benefits. The cultivar 'Tropic Sun' was seeded to 11, 28, and 45 kg·ha<sup>-1</sup>. In each density, 15 cm in length was cut from the main stem at three, four and five weeks after seeding to break apical dominance and encourage additional branching and flowering. Treatments were arranged in a randomized complete block design and replicated four times. Once half of each plot area was terminated at midbloom and the second half was terminated at seed maturity. Litter bags were prepared from sunn hemp residue and removed weekly for six weeks following termination by mowing. Plant height, biomass, tissue carbon and nitrogen, soil nitrogen, soil temperature and moisture, and crop carbon and nitrogen at termination and during decomposition comprise the scope of data collection.

*Specified Source(s) of Funding:* Southern Region SARE

11:30–11:45 am

### Summer Cover Crop Performance in the Gulf States

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Six cover crops were evaluated over two years for biomass production in the summer season at the two sites. The species and seeding rates used included: sunnhemp (*Crotalaria juncea*, 44 kg·ha<sup>-1</sup>); southernpea (*Vigna unguiculata*, 44 kg·ha<sup>-1</sup>), buckwheat (*Fagopyrum esculentum*, 66 kg·ha<sup>-1</sup>); sesame (*Sesamum indicum*, 5.5 kg·ha<sup>-1</sup>); sesbania (*Sesbania macrocarpa*, 27.5 kg·ha<sup>-1</sup>); and a proprietary mix of 70% buckwheat and 30% southernpeas, 44 kg·ha<sup>-1</sup>). Untreated and/or certified organic seeds were broadcast and incorporated at recommended rates in June. Plots received a single irrigation after planting, but received no fertilizer or pesticides prior to or during growth. A 1-m<sup>2</sup> area of crop and weed shoot mass was harvested at two timings. The greatest total fresh (FW) and dry matter (DW) crop biomass production from harvest at Baton Rouge at 90 DAP in 2007 was sunnhemp (62.3 MT·ha<sup>-1</sup> FW; 17.0 MT·ha<sup>-1</sup> DW) and from sesame (51.6 MT·ha<sup>-1</sup> FW; 9.5 MT·ha<sup>-1</sup> DW). Weed biomass was less than 15% of total fresh or dry biomass in these two cover crops.

*Specified Source(s) of Funding:* USDA CRIS MIS-149040 and LA-93859

11:45–12:00 pm

### Effect of Cell Size on Organic Transplants for Field Establishment

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Trends toward sustainability have motivated a new interest in producing healthy transplants. Transplant production of bedding plants, vegetables, pot crops, cutflowers, tissue culture materials, trees and seedlings have become a worldwide business. Transplants are fast replacing traditional bare-rooted transplants or direct seeding in horticulture industry. However, the significance of transplanting stage based on root mass and shoot size is documented only in relatively few crops, and this information is

even more limited for organic transplants. The objective of this study was to establish early stand in the field to take advantage of early demand and premium price. Therefore, an experiment was conducted to investigate the optimal transplant (plug) size for transplanting in the field immediately after the last frost in the spring. Amaranth (*Amaranthus* spp.) and bok choy (*Brassica chinensis*) organic vegetable seeds were sown in plug tray cells of 288 (6.4 cc), 242 (10 cc), 162 (20 c.c), 128 (28 c.c), 98 (35 cc), and 72 (56 cc) containing coir substrate. These transplants were transplanted in the field beds at the same time. The transplants grown in larger cell size were significantly larger with higher root mass and density than the transplants of same age grown in smaller cell size. The larger transplants established easily and quickly, and were ready for early harvest than the smaller transplants. However, the transplants grown in larger cell size needed more greenhouse space, substrate and fertilizers.

Thursday, August 5, 2010

Springs A &amp; B

### Oral Session 36: Viticulture/Small Fruits

10:15–10:30 am

### Effect of Nitrogen Foliar Application on Translocation of <sup>15</sup>N and <sup>13</sup>C in Seyval Blanc Grape

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Nitrogen availability is critical to support canopy development in the early phenological phases of grapevines. It is also necessary to maintain photosynthetic efficiency and productivity of the canopy later in the season. At veraison, when cluster sink activity is elevated, it is fundamental to ensure high leaf source productivity to sustain clusters during rapid growth. Foliar applications can increase leaf nitrogen content, stimulate vegetative growth and modify the vine balance. A field experiment was carried out at the Horticulture Research Center of Michigan State Univ (East Lansing, MI) to evaluate the effect of a foliar spray of nitrogen on the carbon and nitrogen partitioning at veraison. Single cordons of Seyval blanc vines were thinned after fruit set in two separated group of 4 shoots on each cordon, and cropload was manipulated to high and low (2 or 6 cluster per 4 shoots, respectively). At veraison low and high cropload shoots were treated with a low rate nitrate solution (0.5% KNO<sub>3</sub>, 10% <sup>15</sup>N), and with labeled <sup>13</sup>CO<sub>2</sub>. Methods described by Kappes and Flore (1989) were used to pulse <sup>13</sup>CO<sub>2</sub>. Shoot growth rate, final shoot length, leaf area and yield per shoot were not affected by the level of cropload imposed. Nitrogen application did not increase shoot growth or photosynthetic rates post-veraison. Basic fruit

chemistry parameters (Brix%, pH, TA) were not significantly affected by cropload levels, or nitrogen application. Mature leaves, apical leaves and berries were sampled at harvest (30 days after veraison) for a  $^{13}\text{C}$  and  $^{15}\text{N}$  enrichment analysis. All tissues sampled in labeled shoots had increased percentages of enrichment for both  $^{15}\text{N}$  and  $^{13}\text{C}$  when compared to control shoots (non labeled). Within labeled shoots, translocation of  $^{15}\text{N}$  and  $^{13}\text{C}$  from mature leaves to berries and to apical leaves was not affected by the cropload. Non labeled shoots with high and low cropload did not show a significant difference in enrichment of both  $^{15}\text{N}$  and  $^{13}\text{C}$ . We suggest that vegetative sinks and fruit quality parameters could be affected by a redistribution of photosynthetates within the vine that compensated according to the sink demand of each single shoot. However, the pattern of distribution of stable isotopes does not support this hypothesis, rather suggesting that translocation of both carbohydrates and nitrogen is limited to the single shoot.

10:30–10:45 am

**The Impact of Ring Nematode (*Mesocriconema xenoplax*) on Grapevines Grafted onto Different Rootstocks in Field Microplots**

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Vine performance of Pinot noir grapevines grafted onto five rootstocks with known differences in susceptibility to the ring nematode (*M. xenoplax*), or self-rooted, was studied under field conditions in microplots to better understand the physiological effects of ring nematode parasitism and to further test durability of rootstock resistance. Ring nematode population densities increased the fastest on self-rooted vines followed by 3309C and 1103P rootstocks, similar to results from prior greenhouse trials. Little to no nematode population growth occurred in 110R, 101-14 and 420A rootstocks during the first two years, also consistent with previous trials. However, in year three (2008) ring nematode population densities increased dramatically in 110R and 101-14 rootstocks and high population densities were sustained on these rootstocks through year four. Only 420A rootstock remained highly resistant to the ring nematode in this trial. The first effect of nematodes on plant or soil variables occurred below ground in year two (2007). Ring nematode parasitism decreased root growth and mycorrhizal colonization of roots in self-rooted vines and these effects

were detected the next year in nematode-susceptible rootstocks (3309C and 1103P). Nematodes also increased soil respiration in self-rooted vines in year two. Effects of nematode parasitism on above-ground vine performance were not apparent until year three (2008), when shoot length was reduced in self-rooted vines at bloom and in 3309C vines at veraison. Dormant season pruning weights were reduced in both self-rooted and 3309C vines in 2008. Nematodes had no impact on vine nutrient status in 2006, but had variable effects in 2007. By 2008, nematodes reduced potassium in leaves and petioles across all rootstocks and reduced copper in leaves and petioles in self-rooted and 1103P vines. Rootstocks affected vine nutrient status in 2007 and 2008 in a manner consistent with previous published research. The ring nematode did not alter vine N status, gas exchange, leaf water potential, or yield during the first three years of vine establishment. By year four (2009) shoot growth and yield were reduced across all rootstocks by nematodes (main effect), as only one rootstock (420A) out of six had suppressed ring nematode population increases throughout the study.

*Specified Source(s) of Funding:* USDA

10:45–11:00 am

**Effect of Gibberellic Acid on Flowering and Growth of Newly Planted Blueberries**

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Recent studies in northern highbush blueberries (*Vaccinium corymbosum* L.) showed the negative impact cropping in the first two years after planting can have on root, shoot, and crown growth, and on subsequent yields. Late summer applications of  $\text{GA}_3$  and  $\text{GA}_{4+7}$  have been shown to reduce flower bud numbers in potted plants of 'Duke' and 'Bluecrop'. The present study evaluated use of  $\text{GA}_3$  and  $\text{GA}_{4+7}$  at  $400 \text{ mg}\cdot\text{L}^{-1}$  in 'Liberty' in late summer and fall 2006, of  $\text{GA}_{4+7}$  at  $400 \text{ mg}\cdot\text{L}^{-1}$  in 'Liberty', 'Draper' and 'Aurora' in late summer and early Fall 2007, and of  $\text{GA}_{4+7}$  at  $400 \text{ mg}\cdot\text{L}^{-1}$  in 'Draper' and 'Aurora' in late summer and early Fall 2008. Treatment timings over the three years ranged from 7 Aug. to 1 Nov., and plants were treated one, two, or three times, either on consecutive weeks or once monthly. These treatments were compared to two controls, one where plants were allowed to fruit, and one where flower buds were stripped by hand. Floral and vegetative buds were counted in spring of each year. In February 2010, 'Draper' and 'Aurora' plants from the two most effective GA treatments and the two controls were destructively harvested in order to determine the effect on plant growth. Results indicated that  $\text{GA}_3$  and  $\text{GA}_{4+7}$  were equally effective, and that treatments applied in late August and early September were the most effective at reducing the number of flower buds, by up to 50%. Data also suggests that the most effective GA treatments reduced crop load enough to prevent the detrimental effects on plant growth associated with early-cropping.

11:00–11:15 am

### Effects of Preplant Nitrogen and Sulfur Fertilization on Strawberry

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Field studies were conducted to determine effects of preplant nitrogen (N) and sulfur (S) sources on ‘Strawberry Festival’ strawberry (*Fragaria xananassa*) growth and yield. Six treatments resulted from the preplant application of ammonium nitrate [AN (34% N)], ammonium sulfate [AS (21% N and 24% S)], ammonium sulfate nitrate [ASN (26% N and 14% S)], polymer-coated AS [PCAS (20% N and 23% S)], and elemental S (90% S). A non-treated control was added. The N was fixed at 50 lb/acre for AN, AS, ASN, and PCAS, which resulted in S rates of 0, 57, 27, and 57 lb/acre, respectively. The S rate of the elemental S treatment was set at 57 lb/acre. For early fruit number, the highest values were found in plots treated with AS and elemental S, while the highest total fruit numbers were obtained in plots treated with AS, ASN, PCAS and elemental S. There was no difference in total fruit numbers between the non-treated control and AN. Plots treated with elemental S, PCAS, ASN, and AS had the highest early marketable fruit weights, whereas the lowest early marketable fruit weight was found in the non-treated plots. In comparison with the non-treated control plots, all the preplant fertilization programs improved early marketable fruit weight, with AN, AS, ASN, PCAS, and elemental S. Total marketable fruit weights were maximized in plots treated with either preplant AS, ASN, PCAS or elemental S. There was no difference between the total fruit weights obtained in the control and AN-treated plots. The data indicated that the strawberry total yield increases can be attributed to the use of preplant fertilizer sources containing S. This research may lead to a more appropriate use of N for strawberry production in Florida, minimizing the nitrate leaching potential in high sandy soils by eliminating N sources from preplant fertilization programs.

11:15–11:30 am

### Commercial Extracts of the Brown Seaweed *Ascophyllum Nodosum* Enhance Growth and Yield of Strawberries

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Strawberry growers are often looking for sustainable products to enhance yields of their crop. Over three years, one summer and two winter studies conducted in the Oxnard area of California, showed that soil drip-tape applications of seaweed extract (Acadian LSC, Acadian Seaplants Limited) enhanced yield and growth of strawberries. The trial conducted winter 2008/2009

had very high soil salinity levels however leaf sodium levels were reduced and yield enhanced in the seaweed extract treated plots, despite the high soil salinity. In 2007, plant weight was increased 77%, nine weeks after planting. Root length, surface area, volume, and number of tips were increased 27% to 74% when measured with WinRhizo software in 2009. Overall yield was enhanced in all studies, with more early flowers and fruit noted all three years. This yield increase may be due in part to an increase in the numbers of crowns. In all of the studies, the numbers of crowns per plant were increased by 20% to 41%. These results indicate that seaweed extract is an excellent option for enhancing growth and yield of strawberries.

11:30–11:45 am

### On-farm Trials of Alternatives to Methyl Bromide for Raspberry Nurseries

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Methyl bromide has been phased out due to its activity as a stratospheric ozone depleter. Exemptions allowing the use of methyl bromide are increasingly difficult to obtain. Raspberry nurseries rely upon preplant soil fumigation with methyl bromide:chloropicrin (mb:pic) combinations to produce disease- and nematode-free plants. Successful alternatives to mb:pic must provide full control of plant-parasitic nematodes, *Agrobacterium tumefaciens*, and *Phytophthora rubi*. Trials in commercial raspberry nurseries (Macdoel CA, Burlington WA and Lynden WA) evaluated mb:pic and alternative fumigants, including: Midas® (Methyl Iodide:cloropicrin), Telone® C-35 and Pic Clor 60 (Telone:cloropicrin) under conventional (HDPE) and virtually impermeable (VIF) films. *P. rubi* and *A. tumefaciens* control was evaluated with a greenhouse bioassay; *A. tumefaciens* control was also evaluated by soil dilution plating on a selective medium. All of the treatments controlled *P. penetrans* and buried bags of perennial quackgrass and nutsedge propagules. Midas® applied at 350 lb/A under a conventional (HDPE) tarp consistently provided excellent control of all weeds and pathogens. VIF film enhanced efficacy of Midas® applied at 225lb/A and of Telone® C-35 applied at 39 gal/A for controlling *Agrobacterium* and *P. rubi*.

*Specified Source(s) of Funding:* USDA-Pacific Area-Wide Methyl Bromide Alternatives Program

11:45–12:00 pm

### Canopy Light Environment Effects on Phenol and Flavonoid Content of ‘Frontenac’ (*Vitis* spp.) Fruit

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In addition to their many functions within plants, polyphenols contribute greatly to the sensory attributes of wine, and provide many positive effects on human health. It is generally agreed that fruit shading reduces phenol concentrations in grapes and wine, but results have been inconsistent. This study was conducted to determine if the total phenolic and flavonoid contents of ‘Frontenac’ fruit are related to light intensity within the canopy. Four- and 5-year-old ‘Frontenac’ vines were trained to 5 different trellis systems on a fertile site near Crete, NE. Photosynthetically active radiation (*PAR*) was measured with a line quantum sensor both above the canopy and within the fruiting zone at 3 stages of fruit development (berry set, veraison, and harvest) from which percent transmittance was calculated. At all sampling dates, vines grown on Geneva Double Curtain (GDC) and High Cordon (HC) trellises had significantly higher mid-day transmittances than vines grown on Smart Dyson (SD) and Vertical Shoot Positioned (VSP) training systems. Fruit was collected at harvest for chemical analysis. Skins and seeds were separated from the berry pulp, dried in a vacuum oven, and extracted using a 50%:50% methanol:water solution for free phenolics and a 50%:50% methanol:water solution with 1.2 N HCl for bound phenolic compounds. Flavonoid and total phenol concentrations of the bound seed, free skin and bound skin extracts did not differ significantly among trellises. Within the free seed extract, SD had both a significantly lower total phenolic concentration than VSP and the upper canopy of Scott Henry (SH), and a significantly lower flavonoid concentration than VSP, GDC, and the lower canopy of SH. However, when free and bound measurements were combined for each sample, there were no significant differences in phenol or flavonoid concentrations between training systems for skin or seeds. In this study phenol and flavonoid concentrations did not conclusively correspond to light availability in the canopy.

### Thursday, August 5, 2010 Desert Salon 1-3 Oral Session 37: Postharvest Physiology: Cross-Commodity

11:00–11:15 am

#### Changes in Volatile Compounds during Ripening of West Indian-type ‘Simmonds’ Avocado Treated with Ethylene and Aqueous 1-Methylcyclopropene

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Two experiments were conducted to identify volatile compounds during ripening of ‘Simmonds’ avocado (*Persea americana* Mill.) and how the volatile composition is affected by exogenous ethylene and 1-methylcyclopropene (MCP) treatments. For Experiment 1, treatments were: C1—non-treated control; E24—exogenous ethylene for 24 h at 20 °C; MCP—immersion in aqueous formulation of 1-MCP at 150  $\mu\text{g}\cdot\text{L}^{-1}$  a.i. for 1 min at 20 °C. In Experiment 2, treatments were: C2—non-treated control; E12—exogenous ethylene for 12 h, E12+MCP—exogenous ethylene for 12 h + 12 h air + aqueous 1-MCP at 150  $\mu\text{g}\cdot\text{L}^{-1}$  a.i. for 1 min. Treatments were applied to mature-green fruit 24 h after harvest and fruit ripening was monitored at 20 °C. Respiration and ethylene production rates were measured daily, while whole fruit firmness was determined every other day. Fruit were considered commercially ripe upon reaching 10 to 15 N firmness at the equator (5-cm diameter flat-plate probe at 2.5-mm deformation). Fruit were assessed for volatile analysis at mature-green, mid-ripe (half of initial fruit firmness) and ripe maturity stages. Volatiles were collected for 1 h from 100 g of diced pulp using a purge-and-trap system and compounds were identified by GC-MS. In Experiment 1, C1-fruit ripened within 7 d. Treatment E24 hastened the onset of the ethylene climacteric peak by 1 d and ripening by 2 d, while MCP delayed both by 2 d. In Experiment 2, C2-fruit ripened in 6 d. Treatment E12 did not hasten the climacteric nor ripening, but E12+MCP delayed both by 2 d. Total volatiles decreased during ripening, most markedly from mid-ripe to ripe stage. The main group of volatiles identified was sesquiterpenes, predominant in mature-green and mid-ripe stages;  $\beta$ -caryophyllene,  $\alpha$ -copaene and  $\beta$ -cubebene were the most abundant compounds. Hexanal was also a great contributor to total volatiles. Only a few compounds were detected in ripe fruit; alcohols and aldehydes were predominant and several sesquiterpenes were not detected. Reduced amounts of several compounds and total volatiles were

found for MCP-treated fruit when assessed at mid-ripe maturity stage. However, application of exogenous ethylene or 1-MCP did not affect total volatiles in ripe fruit. The additional benefit of shelf-life extension promoted by aqueous 1-MCP treatments corroborates the potential use as a postharvest treatment for the fast-ripening West Indian 'Simmonds' avocado.

11:15–11:30 am

### Characterizing Endogenous and Oxidative Low Molecular Weight Flavor/Aroma Compounds in Fresh Squeezed/Blended Pomegranate Juice

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Little published information exists regarding flavor and aroma compounds in pomegranate (*Punica granatum*) juices. Although arils have fruity and sweet characteristics, we found no publications describing volatile and semi-volatile compounds responsible for their typical flavor. Only two reports were found delivering possible flavor compounds in processed juice, and seed plus rind. Various extraction techniques are used with whole pomegranate fruit, arils or peels to produce juices. Subsequently, we investigated flavor profiles in several 'Wonderful' juice preparations, and the oxidative changes in volatiles with an enzyme inhibitor and under low oxygen blending. Hand-pressed (Miracloth) 'Wonderful' aril juice was analyzed, and compared with blended arils and arils blended with a lipoxygenase inhibitor, n-propyl gallate (n-PG), which restricts secondary volatile generation, arising from oxidation. Comparisons were made with commercial pomegranate juice. A DVB/Car/PDMS SPME was accomplished with 10-ml juice in the headspace of 20-mL vials for 12.5 minute exposure at 40 °C, prior to injection into a HP6890/5973 GC-MS with a DB-5 column. Compounds were identified in triplicate runs by HP ChemStation software searched against the NIST and Wiley libraries. Miracloth expressed arils contained several low molecular weight esters, alcohols, aldehydes and terpenoids. The predominant compounds were ethanol, hexanal, hexanol,  $\alpha$ -pinene,  $\beta$ -pinene, limonene, 4-terpineol and bergamotene. Also recovered were ethyl 2-methylbutanoate, (*E*)-2-hexenal, 2-methylbutyl acetate, ethyl hexanoate, and eucalyptol. Several of these compounds are known to be flavor/aroma-important in fruits. Most aromatic hydrocarbons are derived from the arils but recovery (~2 to 3%) did not approach levels found in commercial juice (22.8%). Carboxylic acids (acetic and 2-methyl propanoic)

were only recovered in peels (0.1 to 0.2%) and commercial juice (22.8%). Terpenes comprised roughly 42 to 50% of the total volatiles recovered in arils which, was markedly higher than levels found in the peel (21%) and commercial juice (4.2%). Esters were preserved well in arils and peels blended under low oxygen conditions and n-PG. Certain compounds (1-butanol, 2,3-pentadione, 2-methyl propanoic acid, 3-methyl-2-butenol, p-xylene and linolool) were only found in commercial 'Wonderful' juice whereas freshly sampled 'Wonderful' only delivered other compounds (1-propanol, 1-penten-3-one, 2-ethyl-furan, propyl acetate, 2-methyl-2-butenal, isobutyl acetate, (*Z*)-3-hexenal, hexanal, (*Z*)-2-hexenal, (*E*)-2-hexenal, (*Z*) 3-hexenol, hexanol, 2-methylbutyl acetate, (*E,Z*) and (*E,E*) 2,4-hexadienal, gamma-terpinene, and numerous terpenes) that were not found in the juice. A long-term goal is to determine important compounds in juices that have flavor importance, while reducing oxidation of undesirable compounds during processing.

*Specified Source(s) of Funding:* USDA CRIS budget

11:30–11:45 am

### Effect of High Temperature on Gene Expression, Volatile Biosynthesis and Postharvest Quality of Banana Fruit during Ripening and Senescence

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Banana (*Musa* AAA group) is one of the most consumed fruit in the world due to its eating quality and nutritional value. Banana fruit quality is dependent on color, flavor (aroma and taste), sweetness and nutritional composition. It has been reported that chlorophyll breakdown and color formation in banana is inhibited by ripening temperatures above 24 °C. At this temperature thylakoid membranes are retained resulting in reduced chlorophyll degradation, but faster senescence. In this study, green (immature), untreated banana fruit were obtained from a local whole-sale market and half of the fruit were subjected to ethylene treatment at 10  $\mu$ L/L for 24 hours. After ethylene treatment, both treated and untreated fruit were stored at 20 or 30 °C for 7 days. During this period, fruit were sampled after 0, 1, 4, and 7 days of storage and evaluated for color, chlorophyll fluorescence, volatile production and expression of genes related to volatile biosynthesis. Storage at 30 °C reduced yellow color development in the peel, decreased chlorophyll fluorescence (Fv/Fm), but increased Fo, indicating possible heat stress of the fruit. A total of 22 volatile compounds were identified using SPME/GC/MS. Both ethylene treatment and high temperature enhanced volatile production. Principal component analysis (PCA) revealed a correlation in the increase of Fo and ethyl



acetate with the stress of high temperature. Using RT-PCR, expression of genes related to volatile biosynthesis including hydroperoxides lyase (HPL), alcohol acetyl transferase (AAT), lipoxygenase (LOX), alcohol dehydrogenases (ADH, short and medium chains) and pyruvate decarboxylase (PDC) were investigated in both peel and flesh tissue. Among the tested genes, AAT, HPL and ADH (medium chain) in peel and flesh tissue increased significantly during ripening and in response to ethylene and storage at 30 °C. ADH (short chain) was induced by ethylene only in the peel. LOX decreased during ripening and storage at 30 °C in the peel, but increased in the flesh tissue of ethylene-treated fruit. No significant change in gene expression of PDC was found. This study demonstrates that both ethylene and high temperature influence volatile biosynthesis in banana fruit at the transcriptional level and confirms findings that high temperature accelerates banana fruit ripening.

11:45–12:00 pm

### Chilling Injury and Quality of Peach in Relation to Season of Fruit Maturity and Low Temperature Storage

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The occurrence of chilling injury (CI) symptoms and fruit quality in different maturing peach (*Prunus persica* L.) cultivars were investigated during fruit ripening before and after low temperature storage. Peach fruit [Florida King (FK), Peach Selection No.3 (PS-3) and Florida Gold (FG) (early maturing cultivars), and Maria Delezia (MD) and Indian Blood (IB) (late maturing cultivars)] were harvested at commercial maturity and were stored at 0 ± 1 °C for 0, 10 and 20 days. Following low temperature storage fruit were allowed to ripe at ambient temperature. The incidence of CI and fruit physio-chemical quality characteristics were studied at fully ripe (eating soft) stage. All cultivars did not show any symptoms of CI during fruit ripening before storage. FG (early maturing) and MD (late maturing) cultivars exhibited better postharvest shelf life and quality during ripening before low temperature storage as compared to other peach cultivars. The fruit of FG were sweeter with highest soluble solid content (SSC), SSC: titratable acidity (TA) ratio, but these fruit exhibited 50% and 75% CI after 10 and 20 days of storage respectively. The fruit of PS-3 exhibited higher fruit firmness, Vitamin-C contents with better taste up to 10 days of storage later on it decreased with higher incidence of CI. Fruit SSC, SSC: TA ratio, reducing sugars, non-reducing sugar, total sugars, percent weight loss, flesh color and color around the stone increased with increase in the fruit storage period. However, a significant decrease was

found in fruit firmness, percent TA and level of vitamin-C with increase in the storage period. Among all the cultivars the IB fruit stored best at 0 ± 1°C up to 20 days with higher fruit firmness; lower percent weight loss; acceptable SSC, SSC:TA ratio, Vitamin-C content and total sugars; and without any symptom of CI during low temperature storage.

### Thursday, August 5, 2010 Springs K & L Oral Session 38: Genetics/ Germplasm/Plant Breeding: Solanaceous Crops

11:00–11:15 am

#### Screening Tomato Lines for Late Blight (*Phytophthora infestans*) Resistance under Conventional and Organic Systems

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Late blight caused by *Phytophthora infestans* is a serious foliar disease in tomato. This disease caused severe damage on tomatoes throughout much of the USA during the summer of 2009. While conventional crops could be managed by scheduled spraying of fungicides, tomato production under organic conditions was a challenge. The objective of this research was to evaluate tomato lines and hybrids grown in a conventional system without fungicides and under organic conditions with approved fungicides to help identify suitable ones for organic production systems. We evaluated 100 tomato genotypes, including breeding lines and hybrids, derived from multiple resistance sources under conventional systems in two locations (Mills River and Waynesville, NC). A sub-set of 20 genotypes consisting of breeding lines, hybrids, and heirloom tomatoes were also evaluated under an organic production system for late blight resistance. The genotypes were scored for late blight in a scale from 0 to 5, 0 indicating no disease at all whereas 5 indicating fully covered with the disease. From the conventional set of experiment, 35 lines did not show any symptoms of late blight at all whereas additional 37 had some symptoms scoring less than or equal to 1. Results from the organic set of experiment were in agreement with the one from conventional. Superior performance of some of the breeding lines and hybrids for horticultural traits along with high level of resistance to the late blight in both experiments indicated that the list of genotypes from this experiment may provide the foundation for further development of late blight resistant tomato in future.

*Specified Source(s) of Funding:* North Carolina Tomato Growers Association

11:15–11:30 am

### Diversity in a Collection of Heirloom Tomato Varieties

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Heirloom tomato varieties are appealing because of their diverse range of color, size, shape, texture and flavor. Heirlooms are largely unimproved for traits such as yield or disease resistance; as such they have attracted efforts of breeders and other researchers who are targeting niche markets. The National Plant Germplasm System (NPGS) Plant Genetic Resources Unit (PGRU) holds the largest tomato (*Solanum lycopersicum* L.) collection in the U.S., many of which are heirlooms. Characterization of the collection will increase its efficiency of use. Replicate plots of 44 heirloom varieties were grown in three locations (Ohio, North Carolina and New York) in 2009. Data were collected for highly heritable horticultural traits and several fruit component traits: ascorbic acid (vitamin C), lycopene, titratable acids and brix. We present the results of phenotypic characterization of the 44 varieties and estimate partitioning of variation and heritabilities of the fruit components.

*Specified Source(s) of Funding:* USDA-ARS

11:30–11:45 am

### Genetics of Southern Blight Resistance in Tomato

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Southern blight caused by *Sclerotium rolfsii* Sacc. is a soil-borne fungal disease of a wide range of plant species occurring throughout tropical and sub-tropical regions. The main objective of this study was to identify molecular markers associated with resistance to southern blight in tomato. A mapping population was generated from a cross between a susceptible tomato cultivar (Fla. 7776) and an accession of *Solanum pimpinellifolium* (PI 126932) with reported resistance to southern blight. The parent lines, F1 and F2 individuals, and F3 families were assayed for southern blight resistance. The plants were inoculated at an age

of eight weeks by *S. rolfsii* grown on rye seeds. Disease severity was estimated by scoring individual plants on a visual scale of 0-4 with increasing severity, and overall survival was recorded. The resistance of PI 126932 and susceptibility of Fla. 7776 was confirmed using the screening procedure. The percent of surviving individuals increased from 10% in the susceptible parent to 90% in the resistant parent. The F<sub>1</sub> individuals had resistance that was similar to the resistant parent. An F<sub>2</sub> population involving 23 extreme resistant and 22 extreme susceptible plants was screened with molecular markers distributed throughout the genome. A locus was found where PI 126932 alleles were significantly associated with the resistant phenotype. Other loci with modifying effects were also detected. The markers associated with southern blight resistance were confirmed in F<sub>3</sub> families. It seems that the resistance is acting as a complex binary trait, presumably controlled by multiple genes and environmental factors. These marker-trait associations may help to isolate the genes conferring resistance, and will be useful in marker-assisted breeding for southern blight resistance.

11:45–12:00 pm

### Mechanical Harvest Trials of New Mexican-type Green Chile (*Capsicum annuum* L.)

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New Mexico-type green chile (*Capsicum annuum* L.) is currently entirely hand-harvested, but lack of a predictable labor supply and higher input costs threaten the viability of the New Mexican-type long green chile industry in the southwestern United States. One of the primary methods to lessen labor requirements and make local production more competitive is adoption of mechanical harvest. Information on relative mechanical harvest efficiency (yield, damage, trash content) of green chile varieties is unavailable and must be developed as a preliminary step towards an overall mechanized system for the crop. Five green chile cultivars (AZ-20, NuMex Joe E. Parker, PHB-109, Despanado, and a TAM breeding line) were direct seeded in a randomized complete block design at New Mexico State Univ's Leyendecker Plant Science Research Center near Las Cruces, NM, in 2009. Plant attributes theorized to contribute to mechanical harvest efficiency (plant height and width, height to fruit set, branching angle, fruit attachment force, and internode length) were measured. Plots were harvested with a commercially available paprika harvester fitted with an inclined helix picking head and manufactured by Yung-Etgar (Bet-Lehem-Hglilit, Israel). No significant differences in mechanically harvested marketable fruit among the varieties were measured. However, harvested trash, amount of broken fruit, and amount of fruit left in the field after harvesting exhibited significant varietal differences. In this trial, wider branching angle appears to correspond to a more dispersed fruit set and

improved mechanical harvest efficiency. Of the cultivars tested, 'Despanado' and 'PHB-109' performed the best with the Yung-Etgar harvester and warrant further evaluation for a mechanical harvest system.

*Specified Source(s) of Funding:* New Mexico Chile Association, New Mexico Chile Commission, and the New Mexico Agricultural Experiment Station

12:00–12:15 pm

### **Skin Color, Scab Sensitivity, and Field Performance of Lines Derived from Spontaneous Chimeras of Norland Potato**

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On the Canadian prairies, consumers favor red-skinned potatoes (*Solanum tuberosum*), with Norland representing the most widely grown red-skinned cultivar. However, the skin color of Norland is not as red as desired, particularly after extended storage. In 2004 three Norland tubers which appeared to have zones of darker skin color were discovered in Univ of Saskatchewan research plots. Plants were grown from sprouts taken from both the light and dark colored zones of these tubers. The change in skin color was stable and heritable; otherwise the plants and tubers were comparable to Norland in all other aspects. This suggests that the color change was due to a chimeral mutation in the epidermis. In field trials conducted in 2005 and 2006 over 30 lines derived from the chimeral tubers were assessed for skin color, yields, tuber configuration and sensitivity to scab. Lines with acceptable yield and tuber configuration as well as enhanced scab resistance and/or superior red skin color were evaluated in replicated trials conducted from 2007-2009. Several lines were identified that had superior red skin color relative to Norland. When grown in fields heavily infested with both common (*Streptomyces scabies*) and powdery scab (*Spongospora subterranea*) several of the new lines also appeared more resistant to common scab than Norland. Yield potential of the selected lines was comparable to Norland and when adjusted for grade out due to excessive scab, yields of several of the chimeral lines were superior to Norland. This study suggests that chimeras may represent a method for rapid, low cost improvement of skin color and scab resistance of potato while maintaining desirable agronomic characteristics.

*Specified Source(s) of Funding:* Robert P. Knowles Scholarship

### **Thursday, August 5, 2010 Springs A & B Oral Session 39: Genetics/ Germplasm: Ornamental Crops**

1:00–1:15 pm

### **Assessing Changes in Morphology, Fecundity, and Disease Resistance of a Natural *Coreopsis leavenworthii* Population during Seed Increase**

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To meet the demand from highway beautification and habitat restoration projects for *Coreopsis leavenworthii* planting stock, seed increase from natural populations is becoming common in Florida. One of the ecological concerns facing seed increase is the potential of genetic shifts (changes) that might occur during this process. To address this issue in *C. leavenworthii*, seeds were collected from a natural population in central Florida in 2006 and increased in both central and northern Florida for three generations from 2007 to 2009. Then seeds from the natural population and the six increase populations were germinated and 525 individuals (75 per natural or increase population) were grown in Summer and Fall 2009 in a common garden study. Plant height, plant dry weight, leaf morphological complexity, days to flower, ray flower size, disc flower size, seed production, and plant resistance to powdery mildew were assessed for each of the individual plants. The mean value of each population was calculated and used to assess potential changes in these aspects during seed increase. On average, plant height and dry weight was 72 cm and 108 grams, respectively. Leaf morphological complexity was 3.4, on a scale of 1 to 6. Plants flowered within 112 days. Flowers had 8 petals, and the size of the ray and disc flowers was 3.4 cm and 0.8 cm in diameter, respectively. Each flower head produced 565 seeds on average. Powdery mildew severity rating was 5.4, on a scale of 1 to 10. These results indicate no significant changes in all of these aspects during the three generation seed increase, or the genetic diversity in the natural population has been maintained.

*Specified Source(s) of Funding:* Florida Wildflower Foundation Inc. and Univ of Florida/IFAS

1:15–1:30 pm

### **Interspecific Hybridization Between *Coreopsis leavenworthii* and *Coreopsis tinctoria* and Effects on Progeny Growth, Development, and Reproduction**

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*Coreopsis leavenworthii* and *Coreopsis tinctoria* are Florida State Wildflowers, and there is considerable interest in production and planting of their seeds. Because of their progenitor-descent relationship, it has been a major concern over their potential to cross-pollinate and the possible effects of such interspecific hybridization on their progeny's growth, development, and reproduction. In this study controlled crosses were produced between the two species to assess the potential effects of interspecific hybridization on their progeny. In controlled pollinations, interspecific crosses produced more seeds than either maternal-parent species and the interspecific seeds germinated as well as either species, indicating full compatibility between the two species. The effects of interspecific hybridization were assessed by comparing F<sub>1</sub> and F<sub>2</sub> generations against the parental generation in plant height, plant dry weight, days to flower, and seeds per flower head. In plant height, both F<sub>1</sub> and F<sub>2</sub> generations were between the parents. The plant dry weight of the F<sub>1</sub> generation was between the parents, but higher than the mid-parent value. The F<sub>2</sub> generation plant dry weight appeared to be on a declining trend. No significant differences in days to flower were observed among parents and the F<sub>1</sub> and F<sub>2</sub> generations. Seed production of the F<sub>1</sub> and F<sub>2</sub> generations was significantly lower than the parents. These results seem to indicate that interspecific hybridization between *C. leavenworthii* and *C. tinctoria* could result in severe outbreeding depression in reproduction, especially in seed production.

*Specified Source(s) of Funding:* Florida Wildflower Foundation Inc. and Univ of Florida/IFAS

1:30–1:45 pm

### **Silencing of a Proteasome Component Delays Floral Senescence**

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Targeted protein degradation via the ubiquitin/26S proteasome pathway is known to play an important function in many phases of plant growth and development. In previous research we demonstrated that silencing a putative E3 ubiquitin ligase (a component of the pathway) delayed floral senescence. To further test the function of targeted protein degradation in flower senescence, we chose to silence an endopeptidase component in the 20S core of the 26S proteasome. *Petunia hybrida* was transformed with a construct allowing for chemically-inducible

silencing of this protein. Flowers from transgenic plants treated with the chemical inducer showed doubled vase life than controls (transgenic flowers held in water). These results indicate that targeted protein degradation plays an important regulatory role in floral senescence.

*Specified Source(s) of Funding:* USDA Floriculture Initiative

1:45–2:00 pm

### **Existence of Multiple Modes of Reproduction in *Lantana camara*, an Invasive Shrub**

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Good fecundity is essential for many invasive species to maintain their invasive potential. *Lantana camara* is among the world's top 10 weedy species and a major invasive species in Florida. Two interesting phenomena have been observed in this species: existence of a series of polyploids and a fair level of female fertility in these polyploids. To find the cause(s) of the female fertility in *L. camara* polyploids, we analyzed the ploidy level distribution in the progeny of tetraploids as well as triploids and pentaploids. Fairly high percentages of pentaploids and/or hexaploids have been observed in the progeny of tetraploids. These higher-than-parent polyploids suggest a common occurrence of unreduced female gametes in *L. camara*. A range of ploidy levels was present in the open-pollination (OP) progeny of triploids: aneuploids, higher polyploids (4x and 5x), and triploids. A similar distribution was also seen in the OP progeny of one pentaploid. The appearance of triploids in the offspring of triploids and pentaploids in the offspring of pentaploids seems to indicate possible apomixis in *L. camara*. To assess this possibility, we analyzed the ploidy level distribution in the progeny of controlled diploid by tetraploid crosses. In addition to triploids and tetraploids, diploids were also present in the progeny of the controlled crosses. These diploids shared the same SSR marker banding patterns and morphological characters with their maternal parents, thus being apomictic in nature. In summary, our ploidy level and molecular marker analyses have provided solid evidence for the existence of multiple modes of reproduction in *L. camara*. These reproductive characteristics of *L. camara* need to be carefully considered in developing and implementing strategies to control the invasiveness of the species.

*Specified Source(s) of Funding:* USDA/TSTAR program, FNGLA Endowment

2:00–2:15 pm

### Genetic Diversity of Flowering Dogwood Maintained Despite Massive Mortality Caused by Dogwood Anthracnose

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Flowering dogwood (*Cornus florida*) populations recently have experienced severe declines caused by dogwood anthracnose. Mortality has ranged from 48% to 98%, raising the concern that genetic diversity has been reduced significantly. Microsatellite data were used to evaluate the level and distribution of genetic variation throughout much of the native range of the tree. Genetic variation in areas affected by anthracnose was as high as or higher than areas without die-offs. We found evidence of four widespread, spatially contiguous genetic clusters. However, there was little relationship between geographic distance and genetic difference. These observations suggest that high dispersal rates and large effective population sizes have so far prevented rapid loss of genetic diversity. The effects of anthracnose on demography and community structure are likely to be far more consequential than short-term genetic effects.

2:15–2:30 pm

### 'Red Star' and 'Purple Cloud': Two New Cultivars of *Primula forbesii* Franch. as Potted Flowers and Bedding Plants

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*Primula forbesii* Franch. (baby primrose) is a biennial wild flower and abundant in many places across Yunnan province in South China. It exhibits many desirable ornamental traits, including rapid growth, long flowering season, loaded flowers and pleasing fragrance. To improve its flower sizes and colors, seeds of wild baby primrose were collected from Kunming and five thousand seeds were germinated and grown in a greenhouse in Beijing in August 2000 as the first generation. We discovered that some ornamental traits of the first generation had been improved slightly, a few of darker pink flowers and special petal features appeared. We germinated seeds, grew plants, evaluated flowers, and collected seeds from darker pink flowers and serrated emarginated petal apices flowers during 2001 to 2004 seasons. After additional four year targeted breeding and selection, two new cultivars, 'Red Star' and 'Purple Cloud', were produced in 2008. Compared with wild ones, both cultivars exhibit many more desirable traits, including much longer flowering season, many more flowers, and stronger fragrance. 'Red Star' is purple-red with large flower diameter and 'Purple Cloud' has petals with serrated emarginated apices that make them look like snowflakes. Both new cultivars could be cultivated as potted flowers and bedding plants. To grow them, seeds usually germinate in two to three weeks at 20–25 °C. After 3–4 true leaves are produced, seedlings should be transplanted into desired pots with peat: perlite based media or outdoor garden. The plants take approximately 3 months from sowing to flowering. They are excellent potted flowering plants for Christmas and the Lunar New Year.

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2:30–2:45 pm

### Comparison of Somatic Chromosomes in *Dendranthema* Species and F<sub>1</sub> Hybrids in Korea

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*Dendranthema* species and  $F_1$  hybrids from the different habitats in Korea were collected to investigate the variation of their somatic chromosomes. The results in this study revealed series of polyploidy in *Dendranthema* from diploids ( $2n=2x=18$ ) up to octoploids ( $2n=8x=72$ ) with the basic chromosome number  $x=9$ . Some of the  $F_1$  hybrids have also intraspecific polyploids as well as aneuploids. Due to *Dendranthema* has shown to comprise series of polyploidy ( $2x, 4x, 6x, 8x$ ), it was possible that polyploidy ( $2x, 4x, 5x, 6x$ ) individuals also produced in  $F_1$  hybrid progeny. Mostly the range of variation was found as diploid ( $2n=2x=18$ ) individuals with *D. boreale*, *D. makinoi* and *D. lineare*, irrespective of whether they occurred together with tetraploid ( $2n=4x=36$ ) of *D. indicum*, *D. zawadskii* ssp. *lucidum*, *D. zawadskii* ssp. *latilobum* var. *leiophyllum*, *D. japonicum*, and hexaploid ( $2n=6x=54$ ) of *D. indicum* for. *albescens*, *D. zawadskii* ssp. *acutilobum*, *D. zawadskii* ssp. *acutilobum* var. *tenuisectum*, *D. zawadskii* ssp. *acutilobum* var. *alpinum*, *D. zawadskii* ssp. *naktongense*, *D. zawadskii* ssp. *yezoense*, *D. zawadskii* ssp. *latilobum* and octoploids ( $2n=8x=72$ ) of *D. zawadskii* ssp. *coreanum*. Number of chromosomes in different species suggests that the hybridization between individuals had repeatedly occurred not only in *D. zawadskii* complex, but also in *D. boreale* and *D. indicum*. As morphological characteristic, intermediate individuals between *D. zawadskii* complex and *D. indicum* suggests that the hybridization occurred with different species respectively. Artificial reciprocal crosses between *D. japonicum* ( $2n=36$ , tetraploid) and *D. indicum* for *albescens* ( $2n=54$ , hexaploid) were made and produced  $F_1$  hybrid ( $2n=45$ , pentaploid). The cytogenetic investigation in *Dendranthema* has been largely directed to ascertain chromosome numbers and the descriptions of chromosome morphology.

2:45–3:00 pm

### In Vitro Propagation of *Colutea gifana*, an Endangered Species in Iran

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In vitro methods provide a variety of tools to supplement traditional methods for collecting, propagating and preserving endangered plant species. In this study, an efficient protocol was developed for in vitro propagation of *Colutea gifana*, a rare and endangered plant species with limited reproductive capacity that grows in a very narrow area of Iran. Single nodes explants were used for a series of experiments to select appropriate disinfection method and growth regulators for establishment, proliferation and rooting stages. Explants showed the highest establishment percent after 15 min treatment with 2% sodium hypochlorite (NaOCl) cultured in MS medium plus  $2.2 \mu\text{M}$  6-benzylaminopurine (BAP) and  $1 \mu\text{M}$  indole-3-butyric acid (IBA). BA was more effective cytokinin in comparison to Thidiazuron (TDZ) and Kinitin (Kn) in proliferation stage and the best result was obtained with  $8.8 \mu\text{M}$  BA. In vitro rooting of proliferated shoots were induced in half-strength MS medium with both tested auxins i.e. IBA and  $\alpha$ -naphthaleneacetic acid (NAA). Eighty percent of the plantlets were successfully acclimatized to ex vitro conditions, exhibiting normal development. These plantlets can be used to replenish declining populations in the wild to conserve *C. gifana* from extinction and also for further studies about this species.

Thursday, August 5, 2010

Springs H & I

### Oral Session 40:

### Crop Physiology: Fruit Crops

1:00–1:15 pm

### Cold Hardiness of Apple Rootstock Trunk and Root Tissues

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Ungrafted clonal apple rootstocks were stored at  $1^\circ\text{C}$  until controlled exposure of the trunk and shoots to  $-12, -15, -18, -21, -24$  and  $-27^\circ\text{C}$  in Dec. 2009. To protect roots from cold temperature injury, the roots were insulated by peat-based media inside a Styrofoam container. Temperature of the media remained above  $-1^\circ\text{C}$  during exposure to subzero temperatures. Internal browning of phloem, cambium and xylem was rated on a scale of

1 to 5 in the lower and upper sections of the tree trunk. Browning of Bud.9 xylem was not affected by any of the temperatures, but purple coloring made visual rating difficult. P.2 was also unaffected. Browning of the xylem occurred at a temperature of  $-24^{\circ}\text{C}$  in G.11 and G.30, and at  $-21^{\circ}\text{C}$  in M.26. Xylem browning was most severe in M.26, G.30 and G.11 which had a rating of 4.0, 3.3 and 2.8, respectively at the coldest temperature,  $-27^{\circ}\text{C}$ . Browning of the phloem and cambium was less severe. Trees were grown in a greenhouse for two months after which shoot growth was measured as an assessment of survival. In Feb. 2010, the same rootstock cultivars were subjected to  $-10$ ,  $-13$ ,  $-15$ ,  $-18$ ,  $-21$  and  $-24^{\circ}\text{C}$  with the roots exposed to these temperatures. Roots were placed inside plastic bags to protect them from desiccation. Relative electrical conductivity of fine root segments increased with decrease in temperature, but did not vary between the different rootstocks. Trees were grown in a greenhouse to assess tree survival.

*Specified Source(s) of Funding:* The International Fruit Tree Association The New England Tree Fruit Research Committee

1:15–1:30 pm

### Responses of Transgenic Apple Trees with Decreased Sorbitol Synthesis to Nitrogen Deficiency

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Sorbitol is the main photosynthetic end-product and the primary translocated form of carbohydrates in apple. When the expression of aldose-6-phosphate (A6PR), the key enzyme in sorbitol synthesis, was decreased via antisense inhibition in 'Greensleaves' apple, both A6PR activity and sorbitol concentration were significantly decreased. As a result, hexose phosphates accumulated in the cytosol at the expense of inorganic phosphate, leading to up-regulation of starch synthesis, organic acid metabolism and amino acid metabolism in the antisense plants. To determine the responses of the transgenic plants to N deficiency, a transgenic line (A10) and the untransformed control (CK) were supplied with 0.5, 2.5, 7.5 or 15 mM nitrogen in Hoagland's solution via fertigation for 7 weeks from mid-May. A10 leaves had significantly higher photosynthesis and chlorophyll concentrations than CK at both 0.5 and 2.5 mM N treatments. 2-oxoglutarate concentration in A10 leaves remained unchanged whereas that in CK increased with decreasing N supply. Oxaloacetate concentration increased with decreasing N supply in both A10 and CK, but it increased to a lesser extent in A10 than in CK. Both soluble proteins and total free amino acids in A10 and CK decreased with decreasing N supply, but A10 had significantly higher levels of soluble proteins and higher levels of aspartate

and glutamate than CK under N deficiency. In addition, A10 leaves had much higher levels of trehalose and maltose than CK under N deficiency. These results indicate that more organic acids are used in amino acid and protein synthesis to maintain higher photosynthesis in the transgenic plants under N deficiency and trehalose signaling might be involved in the responses of transgenic plants to nitrogen deficiency.

1:30–1:45 pm

### Metabolism of Organic Acids, Nitrogen and Amino Acids in Chlorotic Leaves of 'Honeycrisp' Apple with Excessive Accumulation of Carbohydrates

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Metabolite profiles and activities of key enzymes in the metabolism of organic acids, nitrogen and amino acids were compared between chlorotic leaves and normal leaves of 'Honeycrisp' apple to understand how accumulation of non-structural carbohydrates affects the metabolism of organic acids, nitrogen and amino acids. Higher concentrations of non-structural carbohydrates, particularly starch, fructose, sucrose, maltose, maltitol, and trehalose were accumulated in chlorotic leaves, and correspondingly much lower  $\text{CO}_2$  assimilation was observed in chlorotic leaves than in normal leaves, confirming feedback inhibition of photosynthesis in chlorotic leaves. Dark respiration and activities of several key enzymes in glycolysis and tricarboxylic acid (TCA) cycle, ATP-phosphofructokinase, pyruvate kinase, citrate synthase, aconitase and isocitrate dehydrogenase, were significantly higher in chlorotic leaves than in normal leaves. However, concentrations of most organic acids including pyruvate, phosphoenolpyruvate (PEP), oxaloacetate, 2-oxoglutarate, malate and fumarate, and activities of key enzymes involved in the anapleurotic pathway including PEP carboxylase, NAD-malate dehydrogenase and NAD-malic enzyme were significantly lower in chlorotic leaves than in normal leaves. Concentrations of total soluble proteins and most free amino acids were significantly lower in chlorotic leaves than in normal leaves. Activities of key enzymes in nitrogen assimilation and amino acid synthesis, including nitrate reductase, glutamine synthetase, ferredoxin and NADH-dependent glutamate synthase, and glutamate pyruvate transaminase were significantly lower whereas activities of glutamate dehydrogenase and glutamate oxaloacetate transaminase were significantly higher in chlorotic leaves than in normal leaves. It was concluded that, in response to excessive accumulation of non-structural carbohydrates, glycolysis and TCA cycle are up-regulated to "consume" the excess carbon available whereas the anapleurotic pathway, nitrogen assimilation and amino acid synthesis are down-regulated to reduce the overall rate of amino acid and protein synthesis.

1:45–2:00 pm

### Regulation of Return Bloom in ‘Honeycrisp’ Apple by Fruit per Spur

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The strongly biennial apple variety ‘Honeycrisp’ will not bear fruit if the crop load was too high the previous season. Under Michigan conditions, the optimum crop load is 4–6 fruit per cm<sup>2</sup> trunk cross sectional area (TCA). However, adjustment to the optimum does not ensure adequate return bloom. We investigated the effect fruit per spur, fruit position within spur cluster, and seed number per fruit had on return bloom. Individual branches of ‘Honeycrisp’/M9 (10-year-old, 2008), and whole trees of ‘Honeycrisp’/Nic29 (3-year-old, 2009), were hand-thinned to 1 or 2 fruit per spur for <4, 4–6, and >6 fruit per cm<sup>2</sup> branch (F/BCA, 2008) and tree (F/TCA, 2009) cross-sectional area, respectively. At harvest, both fruit and spur-of-origin were coded to relate individual fruit size, weight, seed number and occurrence of bitter pit, to number of return reproductive and vegetative buds. In spring 2009 (branch treatments), all vegetative (simple) and reproductive (mixed) buds per branch were counted on the tagged spurs as well as on the whole branch. 2008 branch treatment spurs with two fruit per cluster were 1) less likely to produce reproductive buds as the crop load increased, and 2) more likely to produce fruit with bitter pit than single-fruited spurs. Other interactions and differences will be discussed. Although the number of seeds per fruit for fruit of one fruit per cluster (spur) was not significantly different, from the values for two fruit per cluster, we suggest that seed number may decrease with increased crop load at a greater rate for solitary fruits than dual fruits. Single fruits were significantly heavier in weight than those grown as doubles at crop loads <4 and 4–6 fruit per TCA, but not at the higher crop load. Flowering data in the spring of 2010 will relate return bloom to previous crop size, fruit growth rate and seed number. Whole tree treatments will be evaluated in spring 2010 for return bloom.

2:00–2:15 pm

### Apple Fruit Size Regulation by AP2 Domain Transcription Factors

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Final fruit size in apple (*Malus x domestica*) is of great economic significance. Apple fruit development involves cell division during the first few weeks after bloom, followed by cell expansion. Final fruit size is greatly regulated by cell production which

is in turn controlled by the activity of multiple genes. Several AP2-domain transcription factors, such as *AINTEGUMENTA* (*ANT*), control growth and organ size in *Arabidopsis* by regulating the duration of cell production and are potential candidates for fruit size regulation in apples. Several ESTs with similarity to *Arabidopsis* *ANT* and *ANT-like* (*AIL*) genes were identified from publicly available apple EST databases. Expression of three such genes, *MdANT1*, *MdANT2* and *MdAIL2*, was analyzed using quantitative RT-PCR during fruit development in ‘Gala,’ across apple genotypes differing in fruit size potential (‘Gala’ and ‘Golden Smoothie’), and in thinned and unthinned fruits. *MdANT1*, *MdANT2* and *MdAIL2* were highly expressed during early stages of fruit growth and exhibited a 4- to 9-fold decline in expression during later stages of fruit development. Decrease in *MdANT1* and *MdANT2* expression coincided with exit from cell production during fruit development in ‘Gala.’ Larger fruit size in ‘Golden Smoothie’ was mostly due to higher cell production than in ‘Gala.’ *MdANT1* and *MdANT2* were expressed at higher levels (2- to 10-fold) and for a longer duration in ‘Golden Smoothie,’ in comparison to ‘Gala.’ Manual thinning to one fruit per cluster increased fruit size in ‘Golden Smoothie’ by increasing cell production. This was associated with increased expression of *MdANT1* (2-fold) and *MdANT2* (5-fold). The above expression data indicate that *MdANT1* and *MdANT2* may be involved in regulating fruit growth and final size in apple by controlling cell production.

2:15–2:30 pm

### Alkenylresorcinols in Peel of ‘Kensington Pride’ Mango Have Antifungal Effects against Anthracnose Disease

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Mango are a sought after tropical fruit that suffers from a short storage life. Anthracnose disease caused by the fungus *Colletotrichum gloeosporioides* is the most common postharvest disease responsible for quality deterioration in mango, and although commercial fungicides can control the disease, we are interested in compounds within the peel that can assist in natural postharvest disease control. Alk(en)ylresorcinols are secondary metabolites that are present in the peel and sap of mango fruit, and when mangoes are harvested, they are typically desapped, resulting in the loss of these metabolites. Here we report on



the changes in concentration of two alk(en)ylresorcinols in mango peel during fruit development and ripening and results of preliminary tests on the effects of these compounds on *C. gloeosporioides* spore germination. 'Kensington Pride' mango fruit were sampled during growth in the orchard, at commercial harvest, and during ripening at 22 °C. Peels were taken, extracted in 95% ethanol, partitioned with dichloromethane, evaporated to dryness and resuspended in ethyl acetate before being separated and identified by HPLC. Ethyl acetate extracts were also run on thin layer silica gel chromatographs and identified spots were removed from the plates, extracted in ethanol and tested for their ability to inhibit germination of anthracnose spores and growth of mycelium. The results indicate that two identified alk(en)ylresorcinols (5-*n*-heptadecenylresorcinol and 5-*n*-pentadecylresorcinol) were present in higher concentrations during early fruit development compared with the mature-green fruit, but that the concentrations did not change from mature-green to eating ripe. Alk(en)ylresorcinol concentrations were 2–3 times higher in the peel of the sun-exposed side of the fruit than in the shaded side. Peel extracts eluted from thin layer chromatography plates inhibited germination of spores of *C. gloeosporioides*, and inhibited growth of cultures on agar plates. The results suggest that the alk(en)ylresorcinols have antifungal activity against *C. gloeosporioides*, the causal organism of anthracnose disease in 'Kensington Pride' mango. More extensive testing is needed, but with 'Kensington Pride' the desapping process at harvest removes much sap containing natural secondary compounds that can help protect the fruit against postharvest disease.

2:30–2:45 pm

### Effects of Crop Load and Irrigation Rate in the Oil Accumulation Stage on Oil Yield and Water Relations of Field-grown 'Koroneiki' Olives

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The interactions between irrigation rates applied during the oil accumulation stage and crop load were studied in field-grown Koroneiki (*Olea europea* L.) olives. The experiment was conducted in a 6-year old super high density orchard. Five irrigation rates were applied from 1 July until harvest. Fresh fruit yield increased with increasing irrigation and oil contents (on a fresh weight basis) decreased dramatically with increasing irrigation rate due to higher water content. Fruit oil weight decreased with increasing crop load and with decreasing irrigation rates. Oil yield increased with increasing irrigation rate from ~3 t/ha to ~5.5 t/ha. Oil yield was unaffected by irrigation rate at low crop loads up to about 2 t/ha and showed augmented positive response with increasing crop load. Our data clearly shows that irrigation affects oil yield on a fruit basis and its effect on a per tree basis is highly dependent on crop load. Stomatal conductance decreased with decreasing stem water potential but a certain level of stomatal aperture was maintained even at extremely low water potentials. Higher stomatal conductance and lower stem water potential were measured in trees with high crop loads and it was more pronounced in lower irrigation rates. While crop load did not affect the relationships between stomatal conductance and stem water potential at the end of June 2009, some effect could be noticed at the end of August, and it was well pronounced in early October.

2:45–3:00 pm

### Lychee Production in Multan, Pakistan

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Lychee industry in Pakistan is only a half century old however, keeping in view its commercial potential, ambitious fruit growers have diversified towards new lychee cultivation. District Multan (30.15°N; 71.36°E) in Punjab, province has a characteristic hot and dry climate where summer temperature reaches up to 45 °C in June–July however it is emerging as one of the major Lychee production areas in Pakistan. The objectives of the study were to understand the adoptability over time in lychee cultivation at Multan and to evaluate genetic diversity in morphological

traits (tree, leaf, flower, fruit), quality parameters (precocity, yield potential, shelf life) and physico-chemical characters (total soluble solids, titratable acidity, ascorbic acid, and organoleptic attributes) of five commercial Lychee cultivars i.e., Gola, Calcutti, Bedana, Bombay, and Madras. This paper will also provide comprehensive information on Multan lychee industry, along with the potential and future prospects.

**Thursday, August 5, 2010 Springs K & L**  
**Oral Session 41: Genetics/  
 Germplasm/Plant Breeding: Vegetable  
 Crops**

1:00–1:15 pm

**Determining Redundancy of Current and  
 Collected Short-day Onion Accessions**

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The mission of the U.S. National Plant Germplasm System is to maintain a representative and genetically-diverse collection of germplasm while doing so in an efficient manner. Reducing genetically-duplicate accessions and adding new and different germplasm to the collection maximizes genetic diversity. This study was conducted to determine redundancies in the current short-day, onion (*Allium cepa* L.) germplasm collection in the U.S. Some accessions appear to be duplicates as indicated by their similar cultivar names. Another objective of this project was to evaluate recently-collected germplasm to determine if there were duplications among them, as well as, between them and the current accessions in the collection. Thirty-six different germplasm accessions and collected cultivars, that were grouped into eight different similarity groups, were seeded in Oct. 2007 and Sept. 2008. As plants of each entry neared maturity, plants from each accession were measured for 18 different morphological characters. These characters included bolting percentage, sheath length and diameter, plant and leaf height, leaf width and thickness, and time when 20% of plants in the plot had reached tops down (20% tops down), 50% tops down, and 80% tops down. Bulbs were harvested at 80% tops down, and at that time, harvest date, pink root disease severity, and bulb number, height and diameter were measured. Two weeks after harvest, average bulb weight, bulb firmness, and the percentage of bulbs with a single growing point were measured. For those groups that had a high degree of bolting, seven characters were measured from bolting plants. These characters included pink root disease severity, bulb height and diameter, shape index, scape length and diameter, and umbel diameter. Five accessions were identified as duplicates of one another and may be removed from the collection. Ten newly-collected

lines were deemed to be different from accessions already in the collection and may add some diversity to the short-day onion collection. Of the traits measured, the most differences between entries were detected by bulb diameter and days to 20% tops down, while the fewest number of differences were detected by sheath length and uniformity of maturity.

*Specified Source(s) of Funding:* This research was funded through a germplasm evaluation grant from the National Plant Germplasm System.

1:15–1:30 pm

**Determining Redundancy of Short-day  
 Onion (*Allium cepa* L. var. *cepa*)  
 Accessions in a Germplasm Collection**

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The U.S. National Plant Germplasm System is one of the world's largest national genebank networks focusing on preserving the genetic diversity of plants by acquiring, preserving, evaluating, documenting and distributing crop-related germplasm to researchers worldwide. Maintaining viable germplasm collections is essential to world food security, but comes at a cost. Redundancy within the collection can incur needless expense and occurs as a result of donations of similar material under different names from different donors. Alternatively, similarly named accessions from different donors can actually be genetically distinct. We evaluated 38 short-day onion accessions using SSR and TRAP molecular markers to compare newly acquired germplasm with current accessions in the collection to determine differences and redundancies. Both marker types distinguished differences and found similarities, but the results didn't always agree. Discriminating among closely related accessions using molecular markers can require a large number of random marker loci, especially when differences may be limited to a single trait. TRAP markers were more efficient, uncovering about 10 polymorphic loci per primer pair.

*Specified Source(s) of Funding:* USDA-ARS

1:30–1:45 pm

**Progress toward Developing Onion Cultivars  
 Tolerant to Iris Yellow Spot Virus**

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In the western U.S., Iris yellow spot virus is a devastating foliar onion disease, that is reducing bulb size and yield, and is difficult to control. The disease is spread by onion thrips and disease symptoms are exacerbated by hot, dry climatic conditions that also favor rapid thrips multiplication and reduced control efficacy.

Currently, no onion cultivar is resistant or tolerant to the virus and/or its symptoms. In the hopes of finding Iris yellow spot (IYS)-tolerant onion germplasm, 75 onion plant introduction accessions from the U.S. germplasm collection were selected and evaluated for leaf color, waxiness (bloom), and axil pattern; thrips number per plant, and IYS disease severity. IYS-infected onion bulbs were placed on the borders of the disease evaluation field to ensure that the virus was present for evaluation. No thrips control means were used during the growing season. Individual plants, that exhibited few IYS disease symptoms, were selected at bulb maturity from 14 different accessions for a total of 181 bulbs. These bulbs were self-pollinated and testcrossed to male-sterile lines in the hopes of finding individual progeny that possess a higher level of IYS tolerance.

*Specified Source(s) of Funding:* This research was funded by the USDA-CSREES Specialty Crop Research Initiative, grant proposal 2008-04804.

1:45–2:00 pm

### **Breeding for Phytonutrient Content: Examples from Watermelon**

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Breeding for high phytonutrient fruits and vegetables can be a fairly straightforward endeavor when the compounds of interest produce a visible effect or the methods for quantifying the compounds simple and inexpensive. Lycopene in tomatoes and watermelon is one such compound, since the amount of red corresponds well with the quantity of lycopene produced. Because of this, breeders have developed high lycopene varieties. High antioxidant concentration in these vegetables creates new marketing tools for improved sales, premium price options, and nutrient packed product. Unfortunately, testing for many health promoting compounds is labor intensive and expensive. For this reason, these compounds are usually not quantified or selected for in breeding lines. Preliminary experiments on watermelon breeding lines showed a wide range in the amount of citrulline (6 fold differences between high and low) and the tripeptide antioxidant glutathione (24 fold differences) expressed within open pollinated varieties. This divergent expression of health promoting amino acids and peptides makes it difficult for industry groups to make blanket health claims for individual crops. By using new strategies and methods, it is becoming easier to test for many of these compounds to insure nutrient

packed produce for the market place. Our finding on citrulline and glutathione demonstrate the feasibility of new analytical technology to develop breeding strategies for developing more nutritive produce.

*Specified Source(s) of Funding:* USDA, ARS

2:00–2:15 pm

### **Resistance in Melon PI 313970 to Cucurbit Yellow Stunting Disorder Virus**

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*Cucurbit yellow stunting disorder virus* (CYSDV; genus Crinivirus, family Closteroviridae), causes a devastating of disease of melon (*Cucumis melo* L.), and is readily transmitted by the sweetpotato whitefly (*Bemisia tabaci* biotype B) resulting in reduced fruit quality and yield. CYSDV was first identified on melons in the 1980s in the United Arab Emirates and has since spread throughout many melon-producing regions in the Middle East and the Mediterranean. CYSDV emerged in the lower Rio Grande Valley of Texas and the adjacent area of Mexico in 1999 and was identified for the first time in the desert melon production regions of southwestern U.S. (Arizona and California) and western Mexico (Sonora) in Fall 2006. It has since been found on melons in Florida in the U.S. (2008) and near Shanghai, China (2008), illustrating that CYSDV is a rapidly emerging virus worldwide. CYSDV has impacted virtually the entire fall-planted melon crop in Arizona and California through 2009, but incidence and impact in spring-planted melons remained low until 2009. Genetic resistance to CYSDV in the African melon accession TGR-1551 (=PI482420; (subsp. *melo*) was expressed as a dominant trait in Spain (monogenic) and Texas (polygenic). We observed PI 313970, a non-sweet melon (subsp. *agrestis* var. *acidulus*) from India, to express high-level resistance to CYSDV in Arizona and California in 2006 when the virus first appeared in these areas. Neither TGR-1551 nor PI313970 was immune to CYSDV as determined by RT-qPCR, and both expressed yellowing symptoms under heavy whitefly feeding pressure typical of the U.S. desert southwest. Inheritance of resistance to CYSDV in PI 313970 was studied in a cross with ‘Top Mark’ in naturally infected field tests in Fall 2008 and Spring 2009. Total plants per entry in seven replications ranged from 30 for ‘Top Mark’ (TM) to 163 for the F<sub>2</sub> family. Reaction to CYSDV infection was evaluated as percent symptomatic leaves per plant. The F<sub>1</sub> and backcross to ‘Top Mark’ were susceptible, indicating resistance in PI 313970 to be recessive. The F<sub>2</sub> and backcross to PI 313970 segregated in accordance with a recessive character and indicated two or more genes were involved. These data suggest TGR-1551 and PI 313970 possess unique, possibly complementary, resistance genes that if combined could provide a higher level of genetic resistance against CYSDV.

*Specified Source(s) of Funding:* USDA, ARS

2:15–2:30 pm

### Comparative Performance of Diploid and Synthetic Tetraploid Populations of Watermelon in the Light of Ploidy Level Changes and Genome Perturbations

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Seedless triploid watermelon is produced by crossing the diploid with a tetraploid line, which is a unique ploidy reconstruction that has to be laboriously carried every growing season. In the current study, a segregating  $F_2$  tetraploid population was generated by selfing a  $F_1$  plant of the cross (*Citrullus lanatus* var. *citroides*, PI 482252  $\times$  *Citrullus lanatus* var. *lanatus*, PI 248178), which was treated with 0.2% colchicine and subsequently screened for ploidy levels. Current research is the first report of molecular characterization of segregating synthetic tetraploid mapping populations and QTL analysis in watermelon. The ploidy level of putative tetraploid watermelon plants was determined by flow cytometry using Ploidy Analyzer PA I (Partec, Germany). The lower epidermis was removed from fully-expanded leaf of 3- to 4-week-old seedlings using a fine forceps, transferred to a microscope slide in a drop of water and covered by a cover slip. The number of chloroplasts per guard cell pair was then counted under 400 $\times$  magnification. In the current research, AFLP fingerprinting was employed to examine a large number of genomic loci across the synthetic tetraploid population and their corresponding parents. The Findgeno subroutine of the TetraploidMap software (Hackett and Luo, 2002) were used to identify the different types of AFLP markers: a dominant marker that were polymorphic across the offsprings present in one parent in single dose (simplex) and double dose (duplex), or present in both parents (double simplex). A genetic linkage map was constructed using *JoinMap* 3.0 (van Ooijen and Voorrips, 2001). Composite interval mapping (CIM) was performed to identify the QTLs related to various important traits using Windows QTL cartographer V2.5 (Wang et al., 2007) with model 6 (standard model) and a LOD threshold score of 3.0. Morphological traits such as shape and size of leaf and flower were different between

the progenies of tetraploids and diploids. The performance of diploid and tetraploid progenies along with their parents showed tetraploids to be superior for the commercially useful traits such as rind thickness, rind hardness, mesocarp pressure, endocarp pressure, soluble solids, number of fruits per plant and fruit yield per plant. In the current study, out of 10 significant QTLs identified, 5 had strong effects linked to fruit length–diameter ratio, rind harness, mesocarp pressure, endocarp pressure and soluble solids.

*Specified Source(s) of Funding:* USDA-CSREES

2:30–2:45 pm

### Population Structure and Association Mapping in Watermelon

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Thirty-five watermelons from the US, Ukrainem and Russia were evaluated for three seasons for their growth and fruit traits. The genotypic data generated by 196 SSR alleles and 1083 AFLPs was utilized to resolve population structure using **STRUCTURE** program. This analysis was conducted assuming two subpopulations ( $K=2$ ) to eight subpopulations ( $K=8$ ) using the SSR data and assuming two subpopulations ( $K=2$ ) to eight subpopulations ( $K=8$ ) using the AFLP data. The clustering results (six subgroups) were used as covariates in the association test (MLM procedure with TASSEL software). Combined means and correlations for various traits across the three growing seasons will be presented. Based on FST distributions across the clusters (Estimated using the program STRUCTURE2.3.2), we assumed that the watermelon cultivars in study have six sub-clusters. This analysis provided evidence on breeding histories based on the shared ancestries. LD (Linkage disequilibrium) was estimated separately for AFLPs and SSR data and marker associations and the corresponding p values will be presented. Our study concluded that there is significant moderate to high LD across the watermelon genome. We performed association mapping using General Linear Model (GLM) and Mixed Linear Model (MLM) with shared ancestry (Q-matrix for both GLM and MLM and Kinship for MLM alone) using both sets of data (AFLP and SSR) across the three years (2005–07) using the program TASSEL 2.1. The P-value determines whether a QTL is associated with the marker and  $R^2$  evaluates the magnitude of the QTL effects. Marker identification through MLM is known to be very robust and 2.5 times more powerful than the

GLM. In the current study, a majority of QTLs showed that they are significant through the multiple years of evaluation. Common markers were identified for fruit length and width as well as soluble solids. This is the first QTL identification study using association mapping approach in watermelon. Best Linear Unbiased Prediction (BLUP) is a standard method for estimating random effects of a mixed model. We used BLUP to predict breeding values of watermelon cultivars taking into consideration of QTL genotype  $\times$  environmental interaction. We conclude that in watermelon improvement programs, application of mixed models with random genetic effects can be very useful to estimate heritable genetic variance of various traits.

*Specified Source(s) of Funding:* USDA-CSREES

2:45–3:00 pm

### **Development for Tri-genomic Hexaploid *Brassica* Populations**

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Synthesis of hexaploid *Brassica* has been stimulated by the successful crossing of *B. carinata* and *B. rapa* followed by chromosome doubling by Prof. Jinling Meng, Huazhong Agricultural Univ (HAU). Three different approaches are underway at The Univ of Western Australia (UWA). The first approach is crossing *B. napus* with *B. nigra* followed by chromosome doubling and over 2000 putative hybrid seeds were harvested. Evaluation of 283 putative hybrids by microsatellite markers, plant morphology, pollen viability and cytology confirmed triploid hybrids. Cuttings were taken and plants were treated with colchicine to double the chromosomes. The second approach involves a two-step crossing design. Two tetraploid species are crossed to produce an unbalanced tetraploid and this unbalanced tetraploid is crossed with a third tetraploid species. High frequencies of unreduced gametes in the unbalanced tetraploids result, and when these unreduced gametes combine with normal reduced gametes of the third tetraploid species, we expect formation of highly heterozygous hexaploids produced without the aid of colchicine. Characterisation of putative hybrids by flow cytometry confirmed one hexaploid and one pentaploid with the remainder at tetraploid level. The third approach involves crossing *B. juncea* with *B. oleracea* followed by chromosome doubling. Putative hybrid seeds were harvested and characterised. An international collaborative project is underway between UWA, HAU and Zhejiang Univ to further develop higher ploidy level *Brassica*.

Monday, August 2, 2010

Springs F &amp; G

## Crop Physiology: Environmental Stress

### (070) Physiological and Biochemical Aspects of Tolerance in *Lepidium Sativum* (cress) to Lead Toxicity

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The present study was undertaken to assess the toxicity of Pb<sup>2+</sup> on photosynthetic pigments, total soluble protein and malondialdehyde (MDA) contents as well as the activities of superoxide dismutase SOD (EC 1.15.1.1), catalase CAT (EC 1.11.1.6) and peroxidase POD (EC 1.11.1.7) in *Lepidium sativum* L. leaves after 10-days of supplying Lead (0-600 ppm) in the nutrient solution. The results indicated that Lead treatment adversely affected plant growth and disturbed the cell metabolism seriously. The development of toxic symptoms, corresponded to a high accumulation of Pb<sup>2+</sup>, was due to the increase in H<sub>2</sub>O<sub>2</sub> and MDA contents decrease in protein content and to the much elevated SOD and POD activities in leaves. In addition, the results demonstrated that the high concentration of lead (Pb<sup>2+</sup> > 400 ppm) could result in a disintegration of the antioxidant system in *Lepidium* seedlings. Also, the significant decrease in the contents of photosynthetic pigments was related to high-level of metal stress. High concentrations of Pb<sup>2+</sup>, especially 400 and 600 ppm, resulted in a great variation in protein pattern distribution. It can be concluded that *Lepidium sativum* can tolerate low levels of lead in contaminated soil.

*Specified Source(s) of Funding:* Deanship of Scientific Research at King Abdul-Aziz Univ, project no. 428/524.

### (071) Response of Tomato to Aluminum Toxicity

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Like all tomato cultivars in this species, (*Solanum lycopersicon* cv. Money Maker) is susceptible to aluminum toxicity. The root system (root tips) presents the first barrier for controlling absorption of the toxic ions into the plant system. Our research is focusing on the identification of genes that are involved in Al toxicity. Identification of such genes is based on alterations in gene expression at both the transcript and protein levels. Genes associated with cellular oxidative stress, detoxification, signal transduction, various transporters, cell cycle progression were all affected by Al toxicity. These included genes such as oxalate oxidase and wali7 homologs, multidrug efflux transporters, adenosyl-L-homocysteine hydrolase lactoylglutathione lyase, multidrug and toxic compound extrusion (MATE) proteins, p34cdc2 protein kinase, cyclin, and histone, putrescine syn-

thesis, ABC transporter, etc. Some of these findings have been published in the following articles: "Proteome changes under Al toxicity in tomato roots", JXB, 2009 60(6):1849-1857 and in the article "Identification of genes associated with aluminum toxicity in tomato roots using cDNA microarrays", Plant Stress, 2008 2:113-120. Our ongoing research is presently directed to validate the function of selected genes by gene-over expression and RNAi knock-down.

*Specified Source(s) of Funding:* USDA

### (072) Response of Heat-tolerant and Heat-susceptible Common Bean Genotypes to Heat Acclimation and Heat Stress

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Heat stress is one of the major limiting factors for common bean (*Phaseolus vulgaris*) production. While management practices could reduce heat stress at a certain degree, breeding heat-tolerant varieties is one of the most important practices to reduce crop yield loss under heat stress. Understanding heat tolerant mechanisms could help breeders improve crop varieties and may help growers better deal with heat conditions. Because heat acclimation could significantly improve crop performance under heat stress conditions, we studied changes in leaf stomatal properties and ultrastructure in mesophyll cells during heat acclimation and heat stress using two heat-tolerant genotypes (85CT-249762 and Strike) and two heat-susceptible genotypes (BBL-247 and BBL-2240). Common bean plants were grown under 25/20 °C day/night temperature in growth chambers for one month and then heat-acclimated at 38 °C for 12 hours. The first trifoliate leaves were removed from plants, placed into sealed test tubes, and merged into 50 °C water incubation for 5, 10, 20, 30, 40, and 60 minutes. The results showed that stomatal resistance in heat-tolerant genotypes was lower under normal growing temperature (25 °C) and heat acclimation temperature (38 °C). Heat-tolerant genotypes maintained lower stomatal resistance for longer time under 38 °C compared to heat-susceptible genotypes. Starch grains in chloroplast became significantly less and smaller after heat acclimation in both genotypes, indicating that starch was hydrolyzed into soluble sugars under high temperatures. Heat acclimation delayed ultrastructural destruction induced by heat stress at 50 °C. The delayed destruction is more significant in heat-tolerant genotypes than heat-susceptible genotypes. In mesophyll cells, nucleolus was the most susceptible structure to heat stress. Thylakoid was more susceptible than chloroplast envelope in chloroplasts. This study suggests that heat tolerant genotypes responded better to heat acclimation temperature and maintained structure intact for longer time under high temperature stress (50 °C) compared to heat-susceptible genotypes.

### (073) Sunburn Susceptibility of 'Golden Delicious' Apple in Ohio as Affected by Several Rootstocks in the 2003 NC-140 Apple Rootstock Trial

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Rootstocks greatly influence tree vigor and thus canopy volume being able to provide shade against excessive solar radiation. Therefore, they have a great indirect effect on sunburn damage of apple fruit. Weak trees with sparse foliage development are likely to bear many sunburned fruit, while vigorous trees suffer little damage. In this trial, the incidence of three types of sunburn (sunburn necrosis, sunburn browning and photooxidative sunburn) on 'Golden Delicious' apple on 23 rootstocks (Bud.62396, B.9, CG.16; CG.3041, CG.5935, CG.6210, G.16, JM.1, JM.2, JM.4, JM.5, JM.7, JM.8, JM.10, JTE.4, JTE.6, M.9, M.9-T337, M.26, PiAu.362, PiAu.51-1, PiAu.51-4, and PiAu.5683) was evaluated. Largest trees and low incidence of sunburn necrosis (<2%) and sunburn browning (<4%) were found on PiAu.5683, JM.5 and PiAu.51-4. Trees grafted onto JTE.6, PiAu51-1, JM.1, JM.4, JM.10, M.9, M.9-T337 and Bud.62396 were of low vegetative vigor and better exposure of fruit to the direct sunlight resulting in higher incidence of sunburn necrosis (>3%) and sunburn browning (>6%). Close relationship between tree vigor and the incidence of photooxidative sunburn was not found. Even though sunburn browning and sunburn necrosis often occurred on larger fruit whereas photooxidative sunburn on smaller ones, close correlation between fruit size and sunburn incidence were not established. Fruit position on a cluster (king vs. side fruit) or fruit number per cluster did not seem to have influence on sunburn incidence.

### (074) The Feasibility of Using Six Landscape Species for the Phytoremediation of Cumene and 4-Cumylphenol

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Chemical manufactures are often associated with a negative publicity due to chemical spills that can cause human health problems and environmental pollution. Innovative methods such as phytoremediation in lieu of traditional remediation methods are being researched to determine environmentally friendly options for remediation. Phytoremediation was studied as an alternative remediation method for removal of chemicals in a contaminated groundwater plume in Louisiana. The main constituents of concern in the plume were cumene and 4-cumylphenol. Two pilot phytotoxicity studies were funded to determine an optimum tree species for removal and control of the constituents of concern. A greenhouse and hydroponic system were constructed to test *Taxodium distichum*, *Salix nigra*, *Juniperus virginiana*, *Pinus glabra*, *Populus deltoids*, and *Quercus nigra* for their phytoremediation capabilities. Both phytotoxicity pilot studies covered a nine month growing period. Trees in the first study were subjected to six water treatments from three of the contaminated groundwater plume monitoring wells. Treatments included undiluted well water containing the constituents of concern; well water containing high salinity levels (>2.0 mS); and several dilutions of each. Three water treatments were tested in the second pilot study, high, low, and deionized water. The high and low water treatments were based on historically recorded high levels of contamination in the plume water. Trees were evaluated monthly for possible health effects of the constituents of concern. Monthly height, trunk diameter, and foliage visual ratings were taken. Initial and final tissue (root and shoot) and soil samples were collected and analyzed for the potential presence and concentrations of the constituents of concern in the tissue and potting media. Monthly water input and discharge samples were collected and analyzed for the constituents of concern. Results from the pilot studies indicated that both the *S. nigra* and *T. distichum* species were acceptable phytoremediation choices. However, *T. distichum* was selected for full scale planting over the groundwater plume because it was tolerant of the contaminated water treatments and salinity levels present in the groundwater. Additionally, *T. distichum* was a low maintenance tree with a conical form that complied with security restrictions at the chemical facility.

*Specified Source(s) of Funding:* Louisiana State Univ

Monday, August 2, 2010

Springs F & G

## Genetics/Germplasm/Plant Breeding: Floriculture

### (001) The Reaction to Daylength of Sunflower Cultivars Grown as Cut Flowers

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Sunflower cultivars grown as cut flowers typically flower in 60 to 80 days after sowing when planted in the field during summer. In conditions of short daylength, flowering of some cultivars is speeded up by as much as 3 weeks, indicating that

they are facultative short day plants. The work of Blacquiere et al. (2002), indicating that sunflowers are sensitive to daylength during the first 3 weeks after emergence suggests that a pre-transplant screening test could be used to classify cultivars on their daylength response. Accordingly, a total of 42 cultivars was sown in 72-cell seedling trays in 2006 to 2009, exposed to either 12- or 16-hour photoperiod on greenhouse benches for 3 weeks, and then transplanted to the field, where they were harvested at flowering, and plant height, flower diameter and leaf number on the main stem measured. In addition, in each screening trial, 'Sunrich Orange' and 'Procut Lemon' were included as standard cultivars. The detailed results for the 42 cultivars screened indicate that the reaction to the daylength treatment imposed ranged from a facultative short day response to a facultative long day response, with 18 cultivars (43%) that showed less than a 7-day difference between long and short day treatments, and thus were considered daylength neutral. Of the 31 cultivars with a 7 day or longer delay in flowering in long days, 6 were delayed from 7 to 13 days, and were considered moderately short day sensitive. Seventeen were delayed more than two weeks, and were classed as extreme short day types. One cultivar, 'Procut Bicolor' flowered 6 days earlier after long than short-day treatment, and was considered to show a moderate long-day response. A correlation analysis of daylength for the two weeks after transplanting with flowering times of the two standard cultivars indicated that 'Procut Lemon' may show a short-day response during that time.

*Specified Source(s) of Funding:* Federal Hatch funds

### (002) Research Concerning the Behavior of New *Callistephus chinensis* Varieties for Enriching the Romanian Floral Assortment

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*Callistephus chinensis* L. it is an annual species. It is an ornamental plant grown in gardens and numerous cultivars are available. The species is very important in the floriculture industry in Japan for cut flowers (www.wikipedia.org.) Our researches were aimed to develop 18 new varieties of *C. chinensis* received from the firm SATIMEX, Germany, for a period of vegetative behavior in Transylvania, Romania, conditions. Observations and determinations were made on the main morpho-decorative characters such as: colors, height of plant, circumference of plant, number of flowers/inflorescence, diameter of flower, diameter of receptacle, number of branched stem per plant, number of ligules and resistance to diseases. The results obtained include great varieties between the characters analyzed. The color of the varieties are white cream (Lady Coral Creamy White), yellow (Sea Starlet Yellow, Harlekin Yellow), pink (Lady Coral Rose), red (Sea Starlet Bright Red, Juwel Purpurit) and blue-violet

(Lady Coral Light Blue, Sea Starlet Lavender, Sea Starlet Violet). The *Callistephus* varieties are vigorous, growing tall from 50.4 cm (Lady Coral Deep Red) to 83.7 cm (Harlekin Violet), with branched stems up to 17.5 cm (Sea Starlet Cream). The flower heads vary from 7.1 cm (Harlekin Yellow) to 10.7 cm (Rose of Shanghai Rose-White), generally having a medium diameter. The form and number of ligules are different, with some flowers having over 500 ligules (Sea Starlet Bright Red, Sea Starlet Violet, Sea Starlet Yellow, Harlekin Crimson, Rose of Shanghai Light Blue and Rose of Shanghai light Rose). All data obtained were interpreted statistically by calculating the average, and the significance of differences was tested. The most representative *C. chinensis* varieties can be used for garden design or as cut flowers in a vase or different summer arrangements.

*Specified Source(s) of Funding:* Univ

### (003) Survey of Wild *Lilium* Species in the Vicinity of the Qin-Ba Mountains, China

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Wild *Lilium* species are widely distributed in the Northwest region of China. They are found in an area of 5000 square km adjacent to the Qin-Ba Mountains through 40 counties in the provinces of Shaanxi, Gansu, Sichuan, Hubei, and Chongqing. To facilitate preservation, protection, and utilization of these valuable germplasm resources, we conducted a survey of their geographic and altitudinal distribution and collected specimens representing different ecotypes. Their morphological characteristics in their native habitat were also recorded. Eight species of wild *Lilium*—*L. lancifolium*, *L. leucanthum*, *L. brownii*, *L. pumilum*, *L. duchartrei*, *L. leichtlinii* var. *maximowiczii*, *L. concolor* and *L. davidii*—were found in the study area. Wild *L. leichtlinii* was found for the first time on Qinling mountain. Of the eight species, we collected 87 ecotypes, including 30 accessions of *L. leucanthum*. The species varied in their altitudinal distribution: *L. pumilum* was found up to 2140m, *L. leucanthum* to 1760 m, *L. brownii* to 650m, *L. davidii* to 550m and *L. concolor* to 460 m. *L. leucanthum* was the most widely distributed in the region, occurring in over 50% of the counties surveyed, followed by *L. lancifolium* and *L. brownii* (46%). *L. duchartrei* was only found in a limited area of Diebu county (Gansu Province). Ecotypes were collected from native habitats varying considerably in soil salinity, pH value and organic matter content.

*Specified Source(s) of Funding:* National Science Foundation of China



### (004) Morphological Characterization of Wild *Lilium* Species Collected from the Vicinity of the Qin-Ba Mountains, China

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The wild *Lilium* species of the Qin-ba mountains are an exciting source of new germplasm for introgression into commercial lily cultivars. Successful implementation of a breeding program requires identification of elite ecotypes as breeding parents. We recorded 18 morphological traits, including flower number, tepal length and width, filament length, pedicel length, bulb depth, scale length and width, height and diameter of the bulb, plant height, stem diameter, and length and width of the lower, middle, and upper leaves for 5 wild *Lilium* species (*L. duchartrei*, *L. lancifolium*, *L. pumilum*, *L. brownie* and *L. leucanthum*). Across the five species, we measured these parameters for 40 ecotypes (5–10 sample plants for each ecotype) in their native habitat. Among the 153 pair combinations of the 18 traits 133 pairs were highly correlated. Through R-type cluster analysis the 18 morphological traits could be divided into five major groups. A formula that uses the 18 traits for identification of the 5 different species in the wild was established. Validation demonstrated that the formula was correct in more than 98% of the tested wild species.

*Specified Source(s) of Funding:* National Science Foundation of China

### (005) Evaluation of 31 Rose Cultivars Grown at the Veterans Memorial Rose Garden

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The original rose cultivars planted at Mississippi State Univ Veterans Memorial Rose Garden were evaluated during the period

of 2007–09. Thirty-one cultivars belonging to the horticultural classes Floribunda (F), Grandiflora (Gr), Hybrid Tea (HT), or Shrub (S) roses were grown in raised brick beds since April 2006. Cultivars are grown on own root, or grafted on *R. ×fortuniana* or ‘Dr. Huey’ rootstocks. Cultivars on *R. ×fortuniana* rootstock are favored by exhibition rose enthusiasts in lower southeastern US for vigor and performance. ‘Dr. Huey’ rootstock is a common understock for roses, particularly in hot climates. All roses at the rose garden are maintained under a systematic spray program and are regularly deadheaded, as they are publicly displayed. Data on plant height, plant width, number of canes per plant, and ratings for black spot, incorporating both defoliation and infection, were collected at end of growing seasons in 2007, 2008, and 2009. The Horsfall-Barratt rating scale was used to generate scores for black spot (Horsfall and Barratt, 1945). In 2008 and 2009, end of season visual plant performance was assessed by rating flower quantity and quality, foliage quantity and quality, and plant habit and vigor on a scale of 1 to 10. After 3 years sufficient growth patterns were established to definitely separate the cultivars into large, medium and small growing roses. Most of the large roses were hybrid teas on *R. ×fortuniana* rootstock. Medium sized roses were hybrid teas and a grandiflora grafted on either rootstock and small sized roses were either hybrid teas on ‘Dr. Huey’ rootstock, floribundas or a groundcover shrub rose. Growth data describes individual cultivars well. Tall and wide roses with few canes indicate an open architectural structure. Roses with many canes are bushy in presentation. Quality ratings help describe the overall health of the rose in terms of both blackspot incidence and strength of the rose at the end of the growing season. This has implications for the health of a rose going into winter conditions. Information is presented in a format that is useful for growers and homeowners to make informed choices that suit their conditions.

*Specified Source(s) of Funding:* Mississippi Agricultural and Forestry Experiment Station

### (006) Controlling Flower Senescence by Inducing Expression of *etr1-1*, a Mutant Ethylene Receptor

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Flowers of ethylene-sensitive ornamental plants transformed with *etr1-1*, a mutant ethylene receptor first isolated from *Arabidopsis*, are known to have longer shelf lives. However,

since ethylene plays a role throughout growth and development, plants constitutively expressing the transgene show a variety of defects including poor germination, poor root growth and high susceptibility to disease. If the mutant receptor is expressed under the control of a specific promoter, a more targeted effect can be achieved. Previous workers have successfully used tissue-specific promoters for this purpose. An even more focused response could be achieved using an inducible promoter system, which would allow expression of *etr1-1* to be initiated at the desired time and stage of development. We have generated petunia plants in which the *etr1-1* mutant protein is over-expressed under the control of a chemically-inducible promoter (GVG). The plants develop normally, and the life of the flowers is almost doubled when the plants or excised flowers are exposed to low concentrations of the inducer chemical (dexamethasone). We are now testing other chemical induction systems including one that responds to low concentrations of alcohol, which may offer a viable approach to commercial application of our findings.

*Specified Source(s) of Funding:* USDA Floriculture Initiative

### **(007) Virus-Induced Gene Silencing of a NAC Transcription Factor Alters Flower Morphology and Accelerates Flower Senescence in Petunia**

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Transcription factors play an important role in plant growth and development. We used the tobacco rattle virus (TRV) based virus-induced gene silencing (VIGS) system as a tool for evaluating the possible regulatory role of NAC transcription factors in petunia petal senescence. The genes encoding NAC transcription factors were identified from a petunia floral EST database. Fragments of these genes were isolated and included with a fragment of a gene encoding chalcone synthase (CHS) in the viral vector, and young plants were infected with the viral construct. The *CHS* acts as a reporter in our purple-flowered cultivar – white flowers or white sectors on purple flowers indicate where gene-of-interest (GOI) has been silenced. Silencing one of the petunia NAC transcription factors, homologous to the *A. thaliana CUC* genes, resulted in petal separation, and petal and anther fusion in the flowers, and early onset of floral senescence.

*Specified Source(s) of Funding:* USDA ARS

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Springs F & G

## **Nursery Crops 1**

### **(290) Assessing the Invasive Potential of 12 *Ligustrum sinense*, *Ligustrum lucidum*, and *Ligustrum japonicum* Cultivars Grown in Northern and Southern Florida**

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Chinese privet (*Ligustrum sinense*) and glossy privet (*Ligustrum lucidum*) have widely naturalized throughout the southeast United States, dominating the understory of mesic forests and displacing native plant communities. Both are serious environmental weeds in Australia and New Zealand. In Florida, chinese privet and glossy privet have escaped cultivation in x and x counties, respectively and are listed by the Florida Exotic Pest Plant Council as Category I invasives and are not recommended for planting by the Univ of Florida IFAS status assessment protocol. A third privet, japanese privet (*Ligustrum japonicum*) has escaped cultivation but is not listed as invasive in Florida. All three species have ornamental value, with numerous cultivars commercially available. Seedlings of chinese privet, glossy privet and japanese privet (wildtype selections) and clonally propagated cultivars, including one hybrid (*L. lucidum* × *L. japonicum*), were obtained in finished 1 gal pots. Field plantings of nine uniform plants of each were installed under full sun conditions in south FL (Fort Pierce, USDA Cold Hardiness 9b) and north FL (Quincy, USDA Cold Hardiness, 8b). Plants were evaluated monthly for flowering and fruiting, and tri-monthly for visual quality. Visual quality was based on a scale from 1 to 5 where 1=poor, and 5=excellent. Visual quality and flowering varied by cultivar and site. Regardless of cultivar, after 72 weeks (Nov. 2009), north FL plants received higher visual quality ratings than south FL plants. However, 'Howard' japanese privet, 'Jack Frost' japanese privet, and 'Variegatum' chinese privet had very good to excellent landscape performance at both sites. After 72 weeks, north FL plants were 1.2 to 2.8 times larger and produced 31 times more fruit than south FL plants. Seed viability and germination experiments were conducted from larger, independent populations of chinese privet, glossy privet and japanese privet. Pre-germination viability was 77% (chinese privet), 96% (glossy privet), and 37% (japanese privet) correlating to 68%, 90%, and 21% germination in the greenhouse, respectively. Germination varied by temperature and light. Under a 12-hour photoperiod, chinese privet had the greatest germination (79%) at 20/10 °C, followed by glossy privet (76%) at 20/10 °C, followed by japanese privet (71%) at 25/10 °C. Field trials will continue to determine stability of variegation.

*Specified Source(s) of Funding:* Florida Department of Environmental Protection

### (291) Effects of s-ABA on the Physiology and Marketability of Various Container-grown Taxa during Short-term Desiccation

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Reduced postharvest care of woody plant material in retail settings can decrease the number of days plants remain marketable. If plants are sold on consignment for growers, reduced sales can lead to poor profitability. This study investigated the effect of spray applications of s-abcisic acid (s-ABA) (ConTego Pro™, Valent Biosciences Corp.) to increase the number of days of marketability for various woody taxa in a simulated retail setting. In the first stage of the study, various well-watered container-grown taxa were treated with a spray application of either 0, 1000 or 2000 mg·L<sup>-1</sup> s-ABA and water was withheld. Daily, desiccation symptoms were recorded to determine if plants had reached the critical wilting point and thus became unmarketable. Marketability was increased about 2–3 days for plants treated with 2000 mg·L<sup>-1</sup> s-ABA compared to nontreated plants. In the second stage, marketability and physiology of *Ligustrum japonicum* ‘Recurvifolium’ (wavy leaf privet) were monitored after plants were treated with spray applications of 0, 500, 1000, 1500 or 2000 mg·L<sup>-1</sup> s-ABA. Stomatal conductance ( $g_s$ ) declined for all plants depending on the concentration applied. Plants treated with s-ABA had lower  $g_s$  rates and remained marketable longer than nontreated plants. All plants fully recovered to pretreatment  $g_s$  rates provided they were rewatered immediately upon reaching the critical wilting point. Spray applications of s-ABA can increase shelf life of select woody ornamentals.

*Specified Source(s) of Funding:* North Carolina Agricultural Research Service, Valent BioSciences, Corp.,

### (292) Evaluation of Two Perennials (*Baptisia australis* and *Physostegia virginiana* ‘Vivid’) in Low-input Nursery Production Systems

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Pot-in-pot (PiP) production systems combined with drip irrigation have shown to be effective in increasing output, while reducing inputs in large container production of woody nursery plants. However, published research examining small container

PiP production is limited. With PiP production as a possible risk management tool for weather extremes, this experiment was designed to evaluate how PiP production compares with above ground container production in a minimal input nursery production system. Two perennials, *Baptisia australis* and *Physostegia virginiana* ‘Vivid’, were evaluated in this experiment. The species were grown in 2-gal containers in both production systems and subjected to low, mid, and high levels of nutrients and irrigation. The high levels of nutrients and water were low by industry standards creating a stressed environment for the plants. The data collected at intervals during the growing season included; plant width (in two perpendicular directions), height, health rating, flowering, and mortality. Both species exhibited lower mortality and higher growth indices in the PiP system in comparison to the aboveground container production. The PiP system provided greater frost protection after spring shoot emergence for fall-planted *B. australis*. Increasing nutrient levels also increased survivability and growth. The varying irrigation regimes did not significantly affect survivability or growth of these two species.

*Specified Source(s) of Funding:* Middle Tennessee State Univ, Faculty Research and Creative Activities Grant

### (293) Plant Growth Regulators to Control Growth of Containerized *Abelia*

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Colorful woody plants normally grown as landscape plants have potential for use in containers. One such plant is *Abelia × grandiflora*, a popular flowering shrub that is drought and heat tolerant, and pest resistant. In order to produce a marketable well-filled container, plants need to exhibit balanced growth with multiple branches and symmetry, and colorful foliage or heavy early flowering. Despite their inherent potential, most abelia benefit from pruning to develop a compact, well-branched form. Manual labor for pruning increases production costs. Plant growth regulators are an effective way to achieve growth control, reduce production costs and produce a marketable plant. *Abelia* genotypes with colorful foliage or early blooming were selected from a plant breeding program at the Univ of Georgia to evaluate the efficacy of growth regulators to develop desirable form in containers. In 2007, three genotypes were given foliar sprays of the gibberelin inhibitor paclobutrazol (Bonzi, 0.4%) at 0, 30, 40, and 50 mg/L. Foliage of another three genotypes was sprayed with a branching agent dikegulac-sodium (Atrimmec, 18.4%) at 0, 30, 40 or 50 mg/L. Growth and flowering data were collected after three weeks, and plants of all six genotypes were then drenched with 0, 30, 40, or 50 mg/L of paclobutrazol. Data were again collected three weeks later. Results showed that with two treatments of paclobutrazol, height and width of all genotypes was reduced. Genotypes treated with Atrimmec exhibited increased branching. In 2008, foliage of five genotypes was sprayed with cyclanilide at 0, 25, 50, 75, or 100 mg/L. After

about five weeks, growth data was collected. Although some genotypic differences were observed, in general, cyclanilide-treated plants had reduced height, growth index, and internode length and increased shoot number. Effect on earliness of blooming was mixed. These results demonstrate that plant growth regulators are effective in controlling growth of abelia in containers and are helpful to produce attractive plants for spring sales.

### **(294) Effects of Biochar on Nutrient Leaching and Plant Growth**

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Biochar is a soil/substrate amendment that has been shown to improve plant growth and adsorb certain chemicals very effectively. Different amounts of biochar were with planting media to determine the effects of the product on nutrient leaching and plant growth. The treatments included a biochar-less control, a 10% by volume disk of biochar situated at the bottom of the pot, 10%, 20% and 30% by volume treatments where the biochar was incorporated into the potting mix. The ammonium, nitrate and phosphorus concentrations in the leachate were measured once a week, and the growth of the plants were measured at the end of the twelve week period. The effects of biochar on nitrogen and phosphorus leaching and growth will be discussed.

### **(295) Leaching Fraction Effects on pH and Electrical Conductivity Measurements in Containers Obtained Using the Pour-through Method**

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Well-established protocols exist for using the pour-through extraction method to estimate substrate pH and electrical conductivity (EC) values for small root volumes. However, little work has been done to test the accuracy and consistency of these measurements in large containers. Our objective was to determine if the amount of distilled water applied to 1-, 3-, 5-, and 10-gal (2-, 8-, 11-, and 27-L media volume, respectively)

would affect leachate pH and EC values or consistency of measurements. Boxwood (*Buxus ×koreana* 'Green Velvet') was selected for this study because it is a common container-grown nursery crop that does not alter pH in the root zone. Distilled water was poured evenly over the media surface in each container 1 h after irrigation to obtain a leachate volume of either 50 mL or 2.5% of media volume and leachate EC and pH were measured. Container size did not affect pH values. Media pH values were 0.1–0.3 points higher when 50 mL leachate was collected, but the difference was only significant during the first two weeks of measurements. There were no consistent differences in pH over container sizes or leaching fraction. Leachate EC values were similar when measured in leachate collected as 50 mL total volume or 2.5% of media volume in 8 and 11 L containers. However, in 27-L containers, obtaining 50 mL leachate resulted in higher EC values than when 2.5% media volume was obtained. Both pH and EC values obtained from 50 mL leachate fractions over container sizes were more consistent than when 2.5% of the media volume was collected. Growers should collect 50 mL of leachate to test media pH and EC, regardless of container size.

### **(296) Organic Media Substrate to Increase the Growth and Development of Ixora Plants**

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The quality of *Ixora* (*Ixora* spp.) plants in flowerpots fundamentally depends on the type of media substrate used for its cultivation, because it has a direct influence on the source of nutrients for the well growth and development on it. The interactions between plant and media substrate are exhibited in the final commercial presentation. In Mexico, the nurseries use impressive amounts of substrates from forest leaf compost (FLC) collected from woods impacting their habitats. In order to avoid the degradation of the woods is the utilization of composts obtained from natural or industrial wastes and waste reduction products of the vermicomposta obtained from the red California worm. A common industrial sugarcane waste used is the sloth used as an organic fertilizers, it has a high value due to its high content of N, P, K, Ca and organic matter. Three organic substrates were evaluated: FLC (0, 20 and 40%), vermicomposta (0, 20

and 40%) and sloth (0, 20 and 40%) mixed with inert substrate: granulated volcanic stone (20%), coconut fiber powdered (20%) and sand (20%). The sloth and vermicomposta added to the substrates increased the growth of *Ixora* plants. The treatment with 40% of sloth positively affected the agronomic traits of plant height and number of leaves; the treatment with 20% of sloth plus vermicomposta showed the highest number of shoots. The treatments with sloth and vermicomposta produced similar results, particularly the number of shoots; they produced higher effects on agronomic traits in comparison with the FLC.

*Specified Source(s) of Funding:* Universidad de Colima

### (297) Evaluation of Organic Substrate on Growing Oleander (*Nerium oleander* L.) Plants

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Oleander (*Nerium oleander* L.) is a woody and everlasting native shrub of the Mediterranean zone that is cultivated in the whole world as ornamental plant. It produces very showy inflorescences in the shape of corymbs terminals and it thinks that it is about 400 you will cultivate with a wide variety of colors. This plant is used widely in tropical and subtropical regions where it is cultivated like ornamental. The plants produced in substratum, present substantial differences with regard to the plants cultivated in soil. During the last years, there have developed more competitive and productive varieties that traditional, new technology that allows a great substitution of the traditional culture in soil, for the hydroponics and substratum. Three different organic substrates were evaluated: land of leaf (LL), vermicomposta (V) and sloth (S) mixed with inert substrate (IS): volcanic stone (20%), cocos fibers (20%) and sand (20%). Five treatments were evaluated by different organic substrate: T1= 60% IS + 40% LL, T2= 60% IS + 20% LL + 20% V, T3= 60% IS + 40% V, T4= 60% IS + 20% V + 20% S, T5= 60% IS + 40% S. The vermicomposta 20% + land of leaf 20% incorporated into the substrate, stimulated a major growth in number of leaves, shoots and height in plants of oleander. The addition of sloth did not have significant effect in any of the variables.

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### (298) Composted Algae as an Alternative Substrate for Horticultural Crop Production: Chemical and Physical Properties

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Due to availability, cost, environmental issues, or a combination of these factors, the use of traditional substrate components like peat and pine bark may be limited in the future. For these reasons, research on a range of woody plants and grasses for use in alternative substrates is ongoing in many laboratories across the U.S. The information presented here is an evaluation of the chemical and physical properties of composted algae (CA) as an alternative substrate or substrate component. Algae harvested from an Algal Turf Scrubber (ATS®) in Florida were composted and analyses were conducted on raw, unamended material. Electron microscopy revealed that CA was composed of a combination of filamentous algae and pennate-type diatoms. Organic and inorganic composition of CA as determined by organic matter by loss on ignition was 32% [ $\pm 0.8\%$  (n=5)] and 68%, respectively. Carbon and nitrogen (N) of CA determined by dynamic flash-combustion GC was 7.4% ( $\pm 0.4\%$ ) and 0.8% ( $\pm 0.1\%$ ) (n=5), respectively. Water extractions using the 1 [CA (50 cm<sup>3</sup>):2 [solution (100 mL)] method incubated for 1 hour on a shaker (150 rpm) were analyzed by IC and ICP (n=5). Nitrate-N, nitrite-N, and ammonia-N levels in extract solution was 275.7 mg·L<sup>-1</sup> ( $\pm 22.2$  mg·L<sup>-1</sup>), 0.8 mg·L<sup>-1</sup> ( $\pm 0.2$  mg·L<sup>-1</sup>), and 1.5 mg·L<sup>-1</sup> ( $\pm 0.6$  mg·L<sup>-1</sup>), respectively. Potassium and phosphorous (total-P) levels in extract solution was 828 mg·L<sup>-1</sup> ( $\pm 46$  mg·L<sup>-1</sup>) and 11 mg·L<sup>-1</sup> ( $\pm 0.2$  mg·L<sup>-1</sup>), respectively. Chloride and sodium levels in extract solution was 189 mg·L<sup>-1</sup> ( $\pm 17.7$  mg·L<sup>-1</sup>) and 48.6 mg·L<sup>-1</sup> ( $\pm 3.3$  mg·L<sup>-1</sup>), respectively. Extract solution pH and EC was 6.90 ( $\pm 0.04$ ) and 5.00 mS·cm<sup>-1</sup> ( $\pm 0.29$  mS·cm<sup>-1</sup>), respectively. Molybdenum was the only essential plant nutrient not detected in CA in any 1:2 extraction method [water, weak acid (0.01 N HCl), or DTPA (2 mM buffered to pH 5.5)]. The bulk density of CA was 0.89 g·cm<sup>-3</sup> ( $\pm 0.04$  g·cm<sup>-3</sup>), and on a volume basis (v/v), CA air space, water holding capacity, and total porosity (n=5) was 4.3% ( $\pm 0.9\%$ ), 34.8% ( $\pm 0.8\%$ ), and 39.1% ( $\pm 0.4\%$ ), respectively. Chemically, CA may have potential as an organic fertilizer or as a substrate or substrate component. CA, however,

has physical properties outside of the range of what is considered acceptable for floral and nursery potting substrates/media.

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Springs F & G

## Plant Nutrition 1

### (169) Application of Vermicompost Extract on Pak-Choi: Effects on Yield, Quality, and Soil Biological Properties

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Application of aqueous extract of vermicompost has been shown to improve plant health, yield and nutritive quality. Few studies have been conducted to determine the effect of vermicompost extract on soil biological properties. The objective of this study was to evaluate the independent effects and interaction between vermicompost extract and soil type on plant growth, mineral nutrient concentration, phytonutrient content and soil biological properties. Pak-choi plants were grown in Oxisol (series), Mollisol (series) and peat based media fertilized with commercial green waste thermophilic compost. Vermicompost extracts were prepared with various extraction methods using 1:10 chicken manure based vermicompost to water dilution and applied weekly at the rate of 200 mL per plant for four weeks. Application of vermicompost extract regardless of extraction methods enhanced plant production, total root length, root surface area, mineral nutrient content, total carotenoids and total glucosinolates in plant tissue across the soil type. Vermicompost extract had negative effect on total phenolics compared to that of mineral nutrient solution and control. All vermicompost extracts regardless of extraction methods provided equivalent effect on plant growth and nutrient concentration in peat based media. However, aerated vermicompost extract with microbial enhancer had smaller effect on plant growth and nutrient concentration compared to that of aerated vermicompost extract and non aerated vermicompost extract in both soils. Greater effect of vermicompost extract over mineral nutrient solution suggests contribution of additional factors besides mineral nutrition. Vermicompost extract improved mineral nutrient status and microbial properties of Oxisol, Mollisol and peat based media. Dehydrogenase activity of vermicompost extract treated soil (133  $\mu\text{g TPF g}^{-1}$  soil) was about 45% higher than that of not treated soil (90  $\mu\text{g}$

TPF  $\text{g}^{-1}$  soil). Vermicompost extract effect on soil respiration ( $\text{CO}_2$  Fluxes  $\mu\text{mol m}^{-2}\text{sec}^{-1}$ ) was generally similar to that of dehydrogenase activity. Moreover, the dehydrogenase activity was positively correlated ( $r = 0.64$ ) with the soil respiration. The findings of this study suggest that vermicompost extract can serve multiple purposes including supplemental source of plant nutrient and enhancing soil biological properties.

*Specified Source(s) of Funding:* USDA - Western Sustainable Agriculture Research & Education (WSARE) and Tropical & Subtropical Agriculture Research (TSTAR) Project Fund

### (170) Influence of Nutrient Solution Concentration and Propagation Substrate on the Growth and Yield of Swiss Chard in Recirculating Hydroponic Culture

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Small-scale hydroponic growers commonly utilize non-hydroponic soluble fertilizers for crop production. Currently, there is limited research information about appropriate nutrient solution concentrations and their interactions with various cultural practices on crop yield responses in commercial hydroponic culture. The influence of nutrient solution concentration (*NCONC*), and propagation substrate (*SBSTR*) on the growth, and marketable leaf yield of Swiss chard (*Beta vulgaris* L. 'Lucullus'), were evaluated in a commercial Nutrient Film Technique (NFT) hydroponic system. Two-week old seedlings of Swiss chard 'Lucullus' were transferred into a commercial NFT hydroponic system under controlled environment greenhouse conditions at the second true-leaf stage. The NFT system comprised of rows (28 cm apart) of PVC Hydro-Troughs (5.1  $\times$  10.2 cm  $\times$  3.7 m) with 4.45 cm diameter holes spaced 20 cm apart (along the trough). The treatments comprised of two propagation substrates (Oasis<sup>TM</sup> or Rockwool cubes), and two concentrations of a soluble fertilizer (15N-2.2P-12.5K), prepared at 150 and 200 mg N liter<sup>-1</sup> ( $C_1$  and  $C_2$ , respectively). At 63 days after transfer (DAT) into NFT culture, mean per plant leaf count (LC), leaf fresh weight (LFW), leaf dry weight (LDW) and leaf area (LA) were significantly ( $p \leq 0.01$ ) higher at  $C_2$  than  $C_1$  with Oasis<sup>TM</sup> cubes. However, with Rockwool only LFW was significantly ( $p < 0.05$ ) increased at  $C_2$ . Mean per plant LC, LFW, LDW and LA across *SBSTR* were respectively, 14%, 64%, 46%, and 54% higher at  $C_2$  than  $C_1$ . Similarly, LFW, LDW and LA were significantly ( $p \leq 0.05$ ) higher in Rockwool, regardless of *CONC*. However, LC was not affected by *SBSTR* and *NCONC*  $\times$  *SBSTR* interaction was nonsignificant ( $P = 0.05$ ). Mean LC, LFW, LDW and LA across *NCONC* were respectively, 10%, 52%, 54%, and 31% higher

in Rockwool than Oasis™ cubes. These observations suggests that Rockwool substrate provided a better root environment for optimum yield of Swiss chard in NFT culture at both nutrient solution concentrations under the conditions of this experiment.

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### (171) ‘Hass’ Avocado Fruit Nutrient Removal as Affected by Production Conditions

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This research was conducted during 2007 and 2008 to improve nutrition practices in ‘Hass’ avocado orchards in Michoacán, Mexico. The objective was to assess the influence of climate (semiwarm semihumid, semiwarm humid, and temperate subhumid), irrigation (irrigated vs. rainfed), and period of bloom and fruit set: crazy (Aug.–Sept.), normal (Dec.–Feb.), and marceña (Feb.–Mar) on the amount of nutrients removed by ‘Hass’ avocado fruit. A total of 864 fruit samples were analyzed, obtained from six orchards and six trees per orchard, considering three flowering periods, four fruit parts (skin, pulp, seed coat, and cotyledons) and two replicates per tree. Dry matter content of N, P, K, Ca, Mg, S, Na, Cl<sup>-</sup>, Fe, Cu, Mn, B and Zn was determined. Nutrient removal was calculated based on the sum of the contents of each nutrient in the different fruit parts, considering their fresh and dry weight. Only N, Ca and Cl<sup>-</sup> removal was affected by the climate in the fruit-producing area. With exception of Cu, the amount of nutrients removed showed no differences between irrigated and rainfed orchards. For most of the analyzed nutrients (N, K, Ca, Mg, S, Na, Fe, Cu, and Mn), fruit set during the “marceña” bloom (harvested in January) had the greatest removal, compared to that of the “crazy” (harvested in July) and “normal” blooms (harvested in October).

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### (172) Effect of Nitrogen Fertilization on Physiochemical Parameters in Habanero Chili Pepper Fruit

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An experiment was conducted with habanero chili pepper during the autumn-winter season in 2009, in order to investigate the effect of nitrogen fertigation in relation with the quality of fruits expressed as physiochemical parameters. Four split doses of nitrogen fertilizer were applied throughout drip irrigation (32, 80, 160, 320 kg·ha<sup>-1</sup>) under a random block plot design with four replicates. Ten fruits per plot were harvested at 150 days after transplant. The juice of fruits were extracted by maceration and the pH, titratable acidity (TA: % ascorbic acid), total soluble solids (TSS), and the relationship among TSS/TA were evaluated. The results showed that values of pH were highest (6.4) at 80 kg·ha<sup>-1</sup> and then declined as the nitrogen doses increased. In contrast the TSS no significant response ( $P=0.405$ ) was founded. On the other hand, a positive linear response of AT ( $P=0.003$ ) was identified with values increasing two times according doses evaluated (0.62-0.12% ascorbic acid). Nitrogen doses and TSS/TA shown a negative linear response ( $P=0.006$ ) lowering since 165.4 at 85.7 units. Finally this study confirmed the effect that nitrogen fertigation has on some physiochemical parameters as pH, TA and TSS/TA of habanero chili pepper.

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### (173) Nitrogen Fertigation in Habanero Chili Pepper (*Capsicum chinense* Jacq.)

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Under open field conditions and throughout drip irrigation, the response of habanero chili pepper (*Capsicum chinense* Jacq. 'Naranja') at four doses of nitrogen fertigation was evaluated. The treatments compared (35, 70, 105, and 140 kg·ha<sup>-1</sup>) were applied under a random design with four replicates. Total and marketable yield were obtained at 120 days after transplant and during three harvests (early, intermediate and later). Quality of the fruit was measured by size as small, large and fruit with form defects not marketable. Additionally, the content of nitrates in cellular extract of petioles was quantified during the growth and development of the crop. Results shown a linear response with yields and the three harvest with the treatments applied, reaching maximum yield (3.0 ton·ha<sup>-1</sup>) at 140 kg N ha<sup>-1</sup>. On the other hand the quality was not affected by any treatment applied, indicating as not dependent factor within the nitrogen fertigation management. A linear positive correlation ( $R^2=0.83-0.66$ ) was found among the nitrate in cellular extract and yield during three dates evaluated. In conclusion it is possible to obtain major yields without affecting the quality expressed as size by the application of greatest N doses. On the other and is possible the use of nitrates test in extract cellular of petiole as a method in nutrimental diagnostic in habanero chili peppers.

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#### (174) Nitrogen Fertigation on Yield and Quality in Greenhouse Tomato

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Under greenhouse conditions and through drip irrigation, the response on yield and quality of crop tomato (*Lycopersicon esculentum* Mill "Beatrice"), the effect of four doses of nitrogen was evaluated. The treatments (250, 500, 750 y 1000kg ha<sup>-1</sup>), were applied by a random design of blocks. The yield (ton ha<sup>-1</sup>) total and commercial were obtained weekly after 110 days of seedling transplant. The quality of the fruit were analyzed trough measurements of total soluble solids (TSS), qualified acidity (AC) and relation SST/AC<sup>-1</sup> during two dates considered early and late period. The results showed that maximum yields were reached at 500 and 750 kg ha<sup>-1</sup> and declined when 1000 kg ha<sup>-1</sup> of N was applied. Values in SST were among 3.17-3.65 Brix, AC were 0.28-0.36 and SST/AC<sup>-1</sup> were 12.64-14.07; however all quality parameters with not significantly effects on the nitrogen fertigation treatments. Results of this study demonstrate that maximum yields of greenhouse tomato can be reached with 500-750kg ha<sup>-1</sup> of nitrogen fertigation and without modification of the quality be modified

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#### (175) Nitrates in Celular Extract of Petiole in Greenhouse Tomato

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The purpose of this study was to obtain information on N-NO<sub>3</sub> sufficiency ranges in sap of greenhouse tomato (*Lycopersicon esculentum* Mill "Beatrice") growing under soil. The experiment was conducted during the winter-spring season on 2003-04. Crescents doses of nitrogen fertigation were applied at the crop during season, varying the nitrogen quantities since 250 until 1000kg ha<sup>-1</sup>. Over the plant growth cycle, samples of the most recently mature leaves was taken, and the sap of central ribbing without foliage was analyzed with portable ionometers. The results shown high correlation between N-NO<sub>3</sub> concentrations and maximum relative yield ( $R^2=0.7858-0.9925$ ). Sufficiency ranges in N-NO<sub>3</sub> concentration associated with 90-100% of relative yields were variables. Intervals found early season shown concentrations between 506 - 582 mg L<sup>-1</sup> of N-NO<sub>3</sub>. Later in season shortest intervals in concentrations were found (201 - 210 mg L<sup>-1</sup> of N-NO<sub>3</sub>). Results of this study illustrate the utility of use of quick nitrate test for monitoring nitrogen nutrition on greenhouse tomato.

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Monday, August 2, 2010

Springs F & G

Postharvest 1

#### (099) Oxidative Enzymic Metabolism of 1-MCP by Tissues and Cell-free Homogenates of Fruits and Vegetables

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A number of fruit and vegetable tissues show high non-specific sorption of 1-MCP. In experiments comparing sorption of gaseous 1-MCP (SmartFresh™ Technology, 765 μmol m<sup>-3</sup>, 18.2 μL L<sup>-1</sup>) to whole and processed apple fruit, sorption rate increased from 3.0 ± 0.2 ng kg<sup>-1</sup> s<sup>-1</sup> in intact fruit to 13.8 ± 2.4 and 28.2 ± 1.5 ng



$\text{kg}^{-1} \text{s}^{-1}$  in halved and fresh-cut wedges, respectively. Peeled fruit also showed sharply enhanced sorption, indicating that sorption was restricted by epidermal tissue and/or enhanced in response to tissue wounding. Sorption by fresh-cut apple was minimally affected by freeze/thaw-mediated tissue disruption (24%) but was strongly inhibited (90%) in response to heating. The objective of this study was to determine if enzymic metabolism participates in tissue 1-MCP consumption. Analyses revealed that cell-free homogenates (CFH) from apple fruit metabolized 1-MCP at rates in excess of  $100 \text{ ng kg}^{-1} \text{ s}^{-1}$ . Activity was negligible in buffer-insoluble residues (cell walls). Typical 1-MCP metabolism assays utilized 10 mL CFH from 5.0 g of tissue along with 10 mL  $125 \text{ mol m}^{-3}$  Na-MES, pH 5.0. The solutions were sealed in 244 mL jars and provided with  $420.5 \mu\text{mol m}^{-3}$  ( $10 \mu\text{L L}^{-1}$ ) gaseous 1-MCP. 1-MCP metabolism occurred optimally at pH 5, and was inhibited by heating (>90%), ascorbate (83% at  $4 \text{ mol m}^{-3}$ ), Na-hypotaurine (75% at 1 mM), hypoxia (45% at  $0.25 \text{ kPa O}_2$ ), sodium docecyl sulfate (63% at  $34 \text{ mol m}^{-3}$ ), and was eliminated upon centrifugation of CFH  $100,000 \times g$ . 1-MCP metabolism displayed saturation kinetics, with a  $K_m$  of  $160 \text{ mmol m}^{-3}$  and  $V_{\text{max}}$  of  $4.12 \mu\text{mol kg}^{-1} \text{ s}^{-1}$ . Asparagus spears rank among the highest of fruits and vegetables in terms of 1-MCP sorption rate and capacity. As with apple tissue, sorption of 1-MCP to asparagus spears was strongly inhibited by heating. By contrast with apple, however, 1-MCP sorption by asparagus was strongly inhibited by freeze thaw (50%) and 1-MCP metabolism was not detected in asparagus CFH. Experiments employing combined CFH from apple and asparagus revealed that asparagus spears contained compounds capable of inhibiting 1-MCP metabolism in apple CFH (75%). 1-MCP metabolism was also detected in CFH from plantain peel but not pulp, consistent with the high and low sorption capacities of the respective tissues. The data suggest that membrane-associated enzymic oxidation rather than physical binding to cellular macromolecules constitutes the primary sink for 1-MCP applied to fruit and vegetable tissues.

### **(100) Understanding How ‘Honeycrisp’ Apples Maintain Crispness by Elucidating Molecular Mechanisms Involved in Softening and Ethylene Production**

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The ‘Honeycrisp’ (HC) apple is new cultivar that has become very popular due to its flavor and unique texture characteristics. A distinct feature of the apple is that it maintains firmness over extended periods of time, including in air, and thus differs from most cultivars. Our objective is to elucidate the biochemical

changes and molecular mechanisms that are responsible for the slow softening of HC compared to a rapidly softening cultivar ‘McIntosh’ (MC). Fruits from both cultivars were picked during the normal harvest period and kept at  $20^\circ\text{C}$  for two weeks. Internal ethylene concentrations (IECs) and flesh firmness of 5 fruit were measured every 3 d, and cortical tissue frozen in liquid nitrogen for further analysis. From these samples, the tissue of three fruit for each sampling date/cultivar was used for RNA extraction. Primers were designed for various ACC synthases (ACSs), ACC oxidases (ACOs), polygalacturonase (PGs), ethylene receptor (ETRs and ERSs), xyloglucan endotransglucosylase (XTHs), expansins (EXPs),  $\beta$ -galactosidase ( $\beta$ -Gal), and arabinofuranosidase (AFase) genes, and used for quantitative real time RT-PCR (qPCR) analyses. The results show that HC fruit kept at  $20^\circ\text{C}$  had lower IECs, both at harvest and storage, than MC fruit. Also, while MC fruit lost more than 33% of their initial firmness values, HC fruit remain almost as firm as at harvest. The qPCR results revealed that the expression of ACO1, ACO2, ACS1, ACS3, ERS1, ETR1, ETR12, ERF1, ERF2, and  $\beta$ -Gal genes by HC fruit were either higher than or equivalent in all dates to the expression level by MC fruits. It was evident that the expression of ACO and ACS genes in the earlier dates was much higher than MC fruits. However, the expression of AFase, PG, and EXP3 genes was significantly higher, at most dates, with MC fruit.

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### **(101) Extending the Honeycrisp Marketing Season in Washington State**

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High demand and premium pricing has led to rapid increases in Honeycrisp acreage in Washington State. Most fruit is packed by December and sold by January. However, with rapidly increasing product demand, the marketing window for this cultivar needs to be extended. Successful fruit storage is complicated by several problems in storage, namely bitter pit and sensitivity to chilling. In 2008, we sampled fruit from 3 mature, annually bearing Honeycrisp orchards in Washington State. Harvest timings were one week prior to anticipated first pick and first pick (best-storing pick). Fruit was held for 1-3 weeks at 50F before being stored at 36F in regular atmosphere (RA), controlled atmosphere (CA: 0.5%  $\text{CO}_2$ , 1.5%  $\text{O}_2$ ), or dynamic controlled atmosphere (DCA: 0.5%  $\text{CO}_2$ , 0.7%  $\text{O}_2$ ) for up to 6 months. Subsamples of fruit were pulled monthly to evaluate storage performance. In general, all fruit kept well until December regardless of storage regimen, harvest maturity, or orchard location. From January on, the expression of bitterpit symptoms and development of greasiness was hastened by RA storage. Soluble solids and titratable acidity did not significantly change over time and none of the lots expressed significant levels of soft scald. Overall we could not distinguish between CA and DCA stored fruit at any point.

These results suggest that Honeycrisp apples may be stored for longer periods of time without compromising fruit quality when utilizing specific controlled atmosphere conditions.

### (102) Volatiles of 'Red Delicious' Apples under Different Storage Conditions

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Apples generate many volatile compounds responsible for apple flavor. The production of volatiles can be altered by several factors such as storage conditions: time, temperature, oxygen availability and carbon dioxide concentration. A small percentage of apples are commercialized immediately after harvesting, while a large percentage is stored, where characteristic flavor volatile compounds can be affected. The objective of this work was to measure volatile compounds in 'Red Delicious' apples produced in Chihuahua, Mexico, during storage at 1 °C under controlled atmosphere (3% CO<sub>2</sub> and 2% O<sub>2</sub>) (CA), conventional refrigeration (CR), and CA plus 7 days of stabilization under CR conditions (CA+CR). Apples were harvested at day 177 after full bloom (0.3 ppm IEC) and stored in chambers under CR, CA or CA+CR for 7 months. Volatile content of fruits was monthly analyzed by SPME-CG-MS. Results indicate that CR apples presented a higher production of flavor volatile compounds in comparison with CA and CA+CR. Ester production raised at first month of storage from 0.29 ppm, at harvesting, to 69.87, 55.37, and 19.49 ppm for CR, CA and CA+CR, respectively. Although the total ester concentration is very similar for both CR and CA apples, the ester composition differed. CR apples produced butyl acetate and 2-methyl butyl acetate in a proportion of 95% of total esters; while CA apples produced ethyl acetate, ethyl butanoate and ethyl-2-methyl butanoate, representing 88.3% of total esters. CA+CR showed 3 main compounds 2-methyl-butyl acetate, butyl acetate and n-propyl acetate representing 97% of total esters. In the post AC period, there was a significant decrease in concentrations of ethyl acetate from 22.3 ppm in CA to 0.01 in CA+CR, ethyl butanoate from 16.8 to 0.05 ppm, and ethyl-2-methyl butanoate from 9.8 to 0.04 ppm. The highest concentration of alcohols was reached at the first month of storage, and was kept that level in CR conditions, while CA and CA+CR caused a decrease after the first month of storage. The main alcohols produced during apple storage were 1-butanol 2-methyl, 1-hexanol, and 2-methyl-1-propanol, in all storage conditions. Aldehydes showed a decrease of 40.73%, 53.41% and 84.92% during the first month of storage for CR, CA, and CA+CR, respectively. Under CA+CR aldehydes significantly increased after the first month of storage reaching 48.86 ppm. The main aldehydes produced during storage were 2-hexenal,

cis-3-hexenal and hexanal. The use of CA storage produced a negative effect on the volatile compounds in comparison with CR and CA+CR failed to reach CR concentrations.

### (103) Effects of Gibberellin on Endogenous Hormone Status and Quality of 'Dong' Jujube Fruit during Postharvest Storage

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Fresh 'Dong' Jujube fruit rich in soluble sugars and vitamin C is commonly consumed in northern China. An experiment was conducted to evaluate endogenous hormone status and postharvest quality of fresh 'Dong' Jujube as affected by exogenous application of gibberellin. After harvest, fruits were sprayed with gibberellin at different concentrations (40, 80, 120, and 160 mg/L) and then stored at 10 °C. A plain water spray was used as control. Fruit samples were assessed at 1, 5, 9, 13, 17, and 21 days after the treatment. Gibberellin application caused significant changes in the contents of abscisic acid (ABA), gibberellic acid (GA), heteroauxin (IAA), and zeatin riboside (ZR) in the fruits. GA content in the control treatment reached the peak value on the 9<sup>th</sup> day while in the 80 mg/L treatment it appeared on the 13<sup>th</sup> day. Contents of IAA and ZR increased gradually and reached their maximum values on the 17<sup>th</sup> day in the fruits treated with 80 mg/L gibberellin. In contrast, IAA and ZR levels were highest on the 13<sup>th</sup> day in the control. In addition, the 80 mg/L treatment showed a lower ABA level compared with the control during storage. Firmness, soluble sugar, and vitamin C in the control fruits tended to decline during storage; however, the postharvest quality of fruits was improved by the gibberellin spray at 80 mg/L. For instance, firmness and contents of soluble sugar and vitamin C in gibberellin treated fruits were 36.5%, 16.7%, and 167.3% higher on average than that of control throughout the storage, respectively. Among all the concentrations tested, gibberellin at 80 mg/L demonstrated the greatest potential for its application in postharvest storage of 'Dong' Jujube fruits. It was estimated that exogenous spray of gibberellin at 80 mg/L could extend the fruit shelf life by 3 to 5 days at 10 °C.

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### (104) Heat Treatments Keep the Quality of Fresh-cut 'Pomona' Peach

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Heat treatment could be an alternative to delay enzymatic browning and firmness losses for fresh cut peaches. Different heat times and processing degrees on fruit could change the effectiveness of the treatment. In addition, the quality of fresh cut peach fruit could be affected by the heat treatment. Short-term heat treatments on quality of fresh-cut 'Pomona' peach (non melting flesh) were applied during different steps of the processing. Intact fruit were immersed in heated water at 50 °C for 6, 15, and 30 min before peeling and cutting. Other wedge peaches were immersed for 30 sec in water at 50 °C. Subsequently around 250 g of cut fruit were packed in polyethylene tray (0.5 L capacity) covered with a permeable plastic film. The cut fruit was stored at 5 °C during 6 d. Changes in color (browning expressed as L\* value), firmness, respiration rate, microbial growth (mesophilic aerobic and psychrotrophic bacteria) and appearance were measured. Treated fruit at 50 °C for 6 min before processing showed the best appearance and lowest enzymatic browning after 6 d. However, small differences were observed in L\* value and firmness during cold storage. All treatments had mesophilic counts below the Chilean Legislation. Respiration rates were higher at the beginning and reduced during the storage for all treatments, but control fruit showed the highest rates. In summary, immersion in water at 50 °C would not affect the metabolic activity and overall quality of nonmelting flesh peach, either whole fruit or fresh cut. This study and the grant for Dr. Obando were supported by FONDEF (Chile) D07i1026 and Fondecyt 3100074, respectively.

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### **(105) Effect of Heat Treatments on the Quality of Fresh-cut 'Ryan Sun' Peaches**

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Currently, consumers demand a high appearance and safety quality of fresh cut fruit without using chemical treatments. For that reason, new friendly environmental alternatives are being studied to delay enzymatic browning and firmness losses in order to prolong the shelf life of fresh cut peach. The effect of mild heat treatments on the quality of fresh cut 'Ryan sun' peach (melting flesh) was evaluated on whole fruit stored at 0 °C until processing. Then, they were submitted to immersions in water at 50 °C for 6, 15 and 30 min. Also an immersion at same conditions for 30 sec was used in peeled and cut fruit (wedge shape). As a control, intact fruits were immersed in cold water (5 °C). After the treatments, about 250 g of cut fruit were packed in polyethylene trays (0.5-L capacity) covered with a permeable plastic film and stored at 5 °C up to 8 d. The microbial growth (mesophilic aerobic and enterobacteria bacteria), changes in color (L\* value), firmness, respiration rate (expressed as mg CO<sub>2</sub> kg<sup>-1</sup> h<sup>-1</sup>) and appearance were evaluated for 8 d at 5 °C. Treated intact fruit at 50 °C for 15 min (T15) before cutting showed a high delay of enzymatic browning and higher flesh firmness than the other treatments, especially after 4 d. Respiration rates were similar to control for immersions at 6 and 15 min. However, the rates were higher in treatments with 30 min and 30 sec for intact and cut fruit, respectively. The highest firmness values of 2 kg<sub>f</sub> were shown by T15. In addition, this treatment kept the color (L\* values) between 62 to 66 along the storage period. Mesophilic counts were below or close the maximum levels allowed by Chilean Legislation after 8 days at 5 °C for all treatments. This study and the grant for Dr. Obando were supported by FONDEF (Chile) D07i1026 and Fondecyt 3100074, respectively.

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### **(106) Effects of Modified Atmosphere on Biochemical and Physiological Characteristics of *Zanthoxylum L. Bud* during Postharvest Storage**

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In order to examine the influence of modified atmosphere on biochemical and physiological characteristics of *Zanthoxylum L. bud* during postharvest storage, seven treatments using different combinations of CO<sub>2</sub> and O<sub>2</sub> levels were evaluated in this experiment: 2% CO<sub>2</sub>/6% O<sub>2</sub>, 6% CO<sub>2</sub>/6% O<sub>2</sub>, 10% CO<sub>2</sub>/6% O<sub>2</sub>, 14% CO<sub>2</sub>/6% O<sub>2</sub>, 6% CO<sub>2</sub>/2% O<sub>2</sub>, 6% CO<sub>2</sub>/10% O<sub>2</sub>, 6% CO<sub>2</sub>/14% O<sub>2</sub>. Air was used as the control treatment. Respiration and ethylene release rate, fresh and dry weight, ethanol and acetaldehyde content, and levels of chlorophyll, soluble sugar, and vitamin C of the fruit samples were measured at 1, 4, 7, 11, 15, and 18 days after storage. Results showed that the appropriate CO<sub>2</sub> and O<sub>2</sub> combinations could decrease the respi-

ration and ethylene release rate, postpone the peak of ethylene release, reduce the loss of fresh and dry weight of *Zanthoxylum* L. bud, and avoid the accumulation of ethanol and acetaldehyde. As a result, contents of chlorophyll, soluble sugar, and vitamin C were well maintained. For example, at 18 days after storage, the chlorophyll, soluble sugar, and vitamin C contents of the bud in the 10% CO<sub>2</sub>/6% O<sub>2</sub> treatment were 1.61mg/g, 2.76%, and 41.2mg/100g, respectively, which were higher than that of the control by 18.1%, 21.3%, and 217.8%, respectively. In this experiment, the best modified atmosphere treatment was 10% CO<sub>2</sub>/6% O<sub>2</sub>, followed by the treatment of 6% CO<sub>2</sub>/6% O<sub>2</sub>. The two treatments could result in a shelf life of *Zanthoxylum* L bud above 15 days. In contrast, the 14% CO<sub>2</sub>/6% O<sub>2</sub> and 6% CO<sub>2</sub>/2% O<sub>2</sub> combinations led to ethanol and acetaldehyde accumulations and reduced the contents of chlorophyll, soluble sugar, and vitamin C, causing a significant decline in the postharvest quality of *Zanthoxylum* L. bud.

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## Monday, August 2, 2010 Springs F & G Sustainable Production 1

### (184) Advanced Sensing and Management Technologies to Optimize Resource Use in Crops. II

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Currently, the application of fertilizer and water in orchard crops follows largely standardized practices with limited consideration of temporal, climatic and crop variability. This approach constrains our ability to improve management, results in loss of potential income and causes negative environmental impact. In this project we strive to address this issue by integrating 1) new approaches to determine crop demand with spatial and temporal accuracy, with 2) advanced methods of estimating current crop status and performance with 3) the development a new site specific orchard management platform. In this poster (#2 of 2), we discuss integrated approaches to define real time crop 'status' for water and nutrients with high spatial and temporal specificity in deciduous perennial crops. In a partner poster we present advanced methods for crop 'demand' determination. A series of 8 research sites were established in 2008 throughout California, New Mexico and Texas in almond, pistachio and pecan. Multiple in-season determinations of crop water and nutrient (all essential elements) have been conducted across all sites using a variety of methods and at several spatial scales from individual tree analysis (>1500 individual data points at each sampling), to within canopy, above canopy and remote (aerial and satellite) imagery. Analyses that have been conducted include: tissue nutrients (tissue sampling and elemental analysis; leaf-canopy-remote spectral analysis); plant water (plant stem water; modeled plant water status/demand (Eddy CoVar modeling, Sebal modeling, Warf Modeling); soil water (neutron probe, soil conductivity and capacitance, direct sampling). Preliminary results will be presented on the following: Nutrient and water variability within and between orchards and time Comparative efficacy of nutrient analyses by multiple methodologies (leaf analysis, SPAD, Ping Meter, NIR, hyperspectral analysis) Comparative efficacy and cross validation of water determination in plant and soils by multiple methodologies (stem water potential, spectral analysis, modeled demand) Impact of fertilizer rate trials and irrigation methodologies on crop response

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### **(185) Influence of Nitrogen Fertilization Rates and Legume Cover Crop on Water Use and Yield Response of Two Sweet Corn Cultivars**

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The goal of this study was to evaluate how a legume cover crop and nitrogen fertilization rates would impact sweet corn cultivars Frosty (C1) and Avalon (C2) marketable fresh yield and water use (WU). The following cover crop (crimson clover, CC), nitrogen rates (no=0N, half=HN and full=FN), and cultivar treatments were applied using randomized complete block design with three replications: 1) CC-0N-C1, 2) CC-0N-C2, 3) CC-HN-C1, 4) CC-HN-C2, 5) CC-FN-C1, and 6) CC-FN-C2. Sweet corn seeds were field planted in the spring of 2009. Frosty and Avalon cultivars were harvested seventy-one days after planting. Four bi-weekly (16 June= vegetative, 2 July= tasseling, 17 July= ear filling, and 28 July= mature ear) volumetric soil water percentages were measured at a depth of 0-30 cm. Treatment CC-FN-C2 produced maximum fresh market yield (12.7 Mg/ha), but that was not statistically greater than those produced by CC-HN-C2 (12.4 Mg/ha). Minimum yield (6.1 Mg/ha) was produced by CC-0N-C1. Between Frosty and Avalon cultivars over all dates, WU was highest for C1 grown in CC-0N and lowest for CC-HN-C1. First year results indicate that cv. Avalon in crimson clover at full nitrogen rate had highest yield and second highest water use while cv. Frosty in CC-0N had lowest yield and lowest WU.

*Specified Source(s) of Funding:* Evans Allen

### **(186) Impact of Inorganic Nitrogen and Legume–Non Legume Cover Crops on Aboveground Biomass Yields and Leaf Area Index of Two Sweet Corn Cultivars**

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During 2009 growing season, a study was conducted to compare cover crops with inorganic nitrogen rates for their influence on above ground biomass (AGB) yields and leaf area index (LAI) of sweet corn cultivars Frosty (C1) and Avalon (C2). The cover crops (fallow=FA, abuzzi rye=AR, and crimson clover=CC), nitrogen rates (no=0N, half=HN and full=FN) and cultivar treatments were applied using randomized complete block design with three replications as follows: 1)FA-0N-C1, 2)FA-0N-C2, 3)FA-HN-C1, 4)FA-HN-C2, 5)FA-FN-C1, 6)FA-FN-C2, 7)AR-0N-C1, 8)AR-0N-C2, 9)AR-HN-C1, 10)AR-HN-C2, 11)AR-FN-C1, 12)AR-FN-C2, 13)CC-0N-C1, 14)CC-0N-C2, 15)CC-HN-C1, 16)CC-HN-C2, 17)CC-FN-C1, and 18)CC-FN-C2. In spring

of 2009, seeds of C1 and C2 cultivars were field planted. AGB was collected about two weeks prior to harvest while LAI was recorded at vegetative (24 June), initial ear (15 July) and harvest week (30 July). Treatment FA-0N-C2 produced highest LAI at harvest week (2.80), while lowest LAI (1.25) was produced by AR-HN-C1 at the vegetative stage. Maximum AGB fresh (24.2 Mg/ha) and dry weight (4.2 Mg/ha) yields were produced by CC-FN-C2 and FA-HN-C2, respectively. Minimum AGB fresh (13.7 Mg/ha) and dry weight (2.2 Mg/ha) yields were produced by AR-HN-C1. Results showed that C2 (cv. Avalon) under FA-0N treatment produced maximum LAI at harvest week while AGB yields of C2 were affected the most by CC-FN and FA-HN. These first year results indicate that cv. Avalon performed better under applied treatments compared to cv. Frosty.

*Specified Source(s) of Funding:* Evans Allen

### **(187) Identification and Evaluation of Endophytic Bacteria on Melon *Sphaerotheca fuliginea***

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Powdery mildew is a serious air-borne fungi disease in melon (*Cucumis melo* L.) throughout major cultivation area of the world. This disease is epidemic in greenhouse and open-field as well as often causes serious economic loss. In present, powdery mildew is one of the most serious disease on melon production in China. The aim of this research is to evaluate the possibility of exploiting endophytic bacteria in the biological control of melon powdery mildew (*Sphaerotheca fuliginea*). 31 strains of endophytic bacteria were isolated from the host (MR-1) with high resistance to powdery mildew in the experiment. Among them, one strain named Mg15 demonstrated better efficacy to control melon powdery mildew in the seedlings biocontrol and leaf disc experiments, which was identified as *Bacillus subtilis* according to morphological, physiological and biochemical characteristics and 16S rDNA sequence. The control efficacy of strain Mg15 was 70.68% in the seedlings. Besides, only 9.29% of the spore germinated from the leaf disc experiment after 12 hours while 60% of the production of conidia decreased compared with the control after 14 days, the hyphae shrank and even deformed after the application of Mg15 fermentation broth observed by scanning electron microscopy. Additionally, the application of Mg15 undiluted fermentation broth had the highest control efficacy on powdery mildew with 80.66% melon seedlings uninfected

in a greenhouse experiment. These results indicated that this strain of endophytic bacteria could be a promising agent for the biocontrol of melon powdery mildew in greenhouse.

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### **(188) Effect of Tillered-onion (*Allium cepa* var. *agrogatum* Don.) Bulb Extraction on Watermelon *Fusarium oxysporum* and Control Efficacy in Greenhouse**

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*Fusarium oxysporum* is a vascular disease of watermelon and leads to serious economic loss on watermelon production worldwide. A lot of chemical methods have been used to control this disease, but the secondary pollution to environment and effect on health are considered by the public gradually. Thus, in this research, a biocontrol method using different concentrations of tillered-onion (*A. cepa* var. *agrogatum* Don.) bulb extraction was studied to estimate the control efficacy on *F. oxysporum*. According to the experiment results, when treated by tillered-onion extraction with concentration of 1000 mg/ml, 500 mg/ml, 250 mg/ml, 125 mg/ml and 62.5 mg/ml, rates of *F. oxysporum* spore germination were 4.66%, 25.71%, 39.53%, 68.58% and 73.93%, respectively. So the inhibition to *F. oxysporum* spore germination enhanced with the increase of tillered-onion extraction. Besides, different concentration of tillered-onion extraction also inhibited *F. oxysporum* hyphae growth. Rates of hyphae inhabitation were 32.37%, 38.68%, 45.53%, 53.42% and 69.21% treated by 62.5 mg/ml, 125 mg/ml, 250 mg/ml, 500 mg/ml and 1000 mg/ml of tillered-onion extraction. Analysis of variance showed that the least of hyphae dry weight (27.1 mg) was obtained treated by 1000 mg/ml of tillered-onion extraction. 250 mg/ml of tillered-onion extraction was the best to control *F. oxysporum* in greenhouse. When treated by this, the control efficacy reached 63.5% on resistant watermelon variety and 65.96% on susceptible watermelon variety. Therefore, tillered-onion could be used as one favorable biocontrol candidate to *F. oxysporum*.

*Specified Source(s) of Funding:* The Earmarked Fund for Modern Agro-Industry Technology Research System (ny-

cytx-36-01-01-02), The Key Natural Science Foundation of Heilongjiang Province (ZJN0705) and The Heilongjiang Excellent Young Foundation (JC200712).

### **(189) Optimizing Hairy Vetch Management in Strip-tilled Sweet Corn**

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The use of leguminous hairy vetch (*Vicia villosa*) as a cover crop in combination with reduced tillage can reduce the economic and environmental costs associated with the use of fossil fuels in food production. Additional economic and environmental benefits may be realized when hairy vetch is grown in combination with winter rye (*Secale cereale*). However, use of hairy vetch is hindered by high seed costs, risks associated with winter-kill in northern climates, and re-growth, especially in reduced tillage systems. New varieties of early-flowering, winter-hardy hairy vetch ('Purple Prosperity' and 'Purple Bounty') may overcome these obstacles, but little is known about their performance in mixtures, or their effects on subsequent crops. This research was conducted to evaluate early-flowering hairy vetch varieties for re-growth following mowing, assess vetch variety compatibility with winter rye, and estimate the impact of vetch monocultures and rye-vetch mixtures on nitrogen dynamics and yield of strip-tilled sweet corn. Cover crop treatments were bare ground, winter rye ("Wheeler") alone, and three varieties of hairy vetch (Purple Prosperity and Purple Bounty with "Oregon" vetch as a control) grown alone and in mixture with rye. Initial N application rates were reduced in cover crop treatments using N credits (25 lb for rye, 75 lb for vetch and 75 lb for rye-vetch) based on cover crop biomass. No remarkable re-growth was observed for any of the vetch varieties despite significantly earlier flowering in the new varieties. New vetch varieties had equivalent overwinter survival and overall biomass production compared to Oregon vetch when grown alone or in mixture with winter rye. Initial soil nitrate levels in bare ground and vetch-only plots were about twice that of rye and rye-vetch plots. Rapid early declines in nitrate levels in these treatments suggest that much of this initial nitrate was irrecoverably lost. Slower mineralization in rye and rye-vetch treatments suggests better synchrony with sweet corn demand early in the season. However, lower nitrate levels in these treatments late in the season suggest that higher rates of side-dressing may have been desirable to insure against possible yield losses. Despite reduced initial application rates of N in cover crop plots, there were no significant differences in sweet corn yield between the bare ground, rye only, vetch only and rye-vetch plots. These results suggest that the early-flowering vetch varieties are suited for use in northern climates and can adequately supply the early season N demands of strip-tilled sweet corn.

*Specified Source(s) of Funding:* USDA-CSREES grant through the C.S. Mott Group for Sustainable Agriculture

### **(190) Utilizing Composted Fish Waste Solids as a Medium Supplement for Flow-through Aquaponic Lettuce Production**

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Aquaculture systems produce nutrient rich effluent that must be managed in order to reduce environmental impact. Remediation through aquaponics, the integration of plant and fish culture, can reduce this impact and provide an opportunity to culture harvestable value-added crops. This experiment examined the food crop production capabilities of cold water (12°C) flow-through aquaponics utilizing the effluent produced in a raceway aquaculture system. Currently, production consists of floating rafts to support the plants and these rafts contain vermiculite (plant growing medium) as the growing substrate for the plants. This plant growing medium is an extra cost to the grower and a more sustainable substitute would be desirable. One such replacement could be developed from the fish waste solids that are produced from the aquaculture system, which would eliminate the extra production cost of purchasing the necessary plant growing medium. This research investigated the feasibility of using composted fish waste solids as an amendment to standard plant growing media for aquaponic lettuce production. The solids were collected and concentrated from the flow-through aquaculture raceway quiescent zones utilizing Geotube® (geotextile) containers. Fish waste solids were collected in the Geotube® for about 6 months and then removed from the aquaculture system. The contained fish waste solids were allowed to compost for 6 months. The composted fish solids were removed from the Geotube® and were incorporated into fine grade vermiculite at rates of 0, 25, 50 and 75% compost/medium volume. *Lactuca sativa* 'Red Sails' (Red Sails lettuce) were direct seeded into speedling trays (128 cell trays, 3.8cm<sup>2</sup>/cell) into the different media formulations for a 12-week trial. Lettuce was grown in flow-through channels 0.5m wide x 2.5m long inside a high tunnel utilizing the fish wastewater effluent as the aquaponics water source. At the end of 12 weeks, total harvestable weights per media treatment were collected. Results indicate that composted fish waste solids significantly increase the total harvestable weights. The 50 and 75% fish waste solid medium incorporations significantly produced more total harvestable lettuce as compared to 0, 25 or 100%. There was a drop in total harvestable weights from 75 to 100% fish waste solid media incorporation. This composting system has great potential to provide a more environmentally sound and sustainable method of fish waste solids management with the added benefit of value-added use.

*Specified Source(s) of Funding:* USDA CSREES

Monday, August 2, 2010

Springs F & G

### **Undergraduate Poster Competition 1**

#### **(334) More Than Just Green Architecture: An Investigation into the Flowering of the Gardens of Louis XIV**

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The legendary gardens of Versailles under King Louis XIV, 17<sup>th</sup> century King of France, are best known for their emphasis on strictly ordered and geometric nature. Most notable are the tightly controlled hedges, allées, and intricately-patterned parterres, creating finite formal geometries, or 'green architecture'. Although King Louis favored rigid formality and design in his gardens, he also had a more private, but nonetheless avid, passion for horticulture and flower collecting. This paper investigates Louis's enthusiasm for horticulture and flowers and why it is relatively unknown today. The far more public, main gardens of Versailles were designed, at Louis's bidding, to project the grandeur of the kingdom. However, underneath this broadly publicized image, King Louis had a more personal enthusiasm for horticulture. He was a leader in the popular *curieux fleuriste*, or curious florist, movement, which focused on the collection and cultivation of the rarest and most exotic flowers. For both men and women, this collection and cultivation demonstrated one's taste, distinction, and wealth. For the King, this hobby also displayed his power and control, here, over nature. King Louis ordered the Grand Trianon to be richly decorated with some of the finest flowers to assist in the portrayal of his powerful god-like image as the Sun King, and as the harbinger of the Second Golden Age with its eternal springtime. He also dispatched his own curious florists to collect rare flowers for him, and richly rewarded their acquisitions, which were subsequently displayed in his Trianon gardens at Versailles and at Marly. However, the most rare and exotic of these plants were sent to Louis's private gardens, for the sole viewing pleasure of the king and his mistresses. Unbeknown to most, Louis's great gardens had been more than just tightly controlled 'green architecture'. In the private areas of his royal gardens, Louis had created a floral paradise driven by ego, seduction, and prophecy.

*Specified Source(s) of Funding:* self

#### **(335) Effects of Daminozide on Flower Production and Sex Ratios in Hydroponic Greenhouse Cucumbers (*Cucumis sativus*)**

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Plant growth regulators have been used to manipulate flowering in cucumber production. We investigated the effect of early applications of daminozide, a plant growth regulator, on plant growth, flower production and sex ratios in hydroponically grown cucumbers. Twenty-four cucumber plants were grown in Hailstorm, a recycled plastic media, irrigated by a closed hydroponic system. Four groups of six individual plants, were subjected to differing growth regulator treatments. The treatment groups consisted of: 1) one application of daminozide (3750 ppm) at the two true leaf stage, 2) one application of daminozide (1875 ppm) at the two true leaf stage, 3) two applications of daminozide (1875 ppm) at the two true leaf stage and then again at the six leaf stage, and 4) no application of daminozide. Leaf numbers and vine heights were measured weekly throughout the experiment. The number and sex of the flowers were recorded weekly for a period of 3 weeks. The results provide useful information regarding the applicability of incorporating daminozide applications in a hydroponic cucumber production system.

*Specified Source(s) of Funding:* Undergraduate Research Experience and Creative Activity - URECA, Middle Tennessee State Univ

### **(336) Plants, Happiness, and Grades: Are They Connected?**

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The objective of this study was to determine if the interaction of Univ students with plant life and green space, from walking or riding to class to keeping houseplants to a view of nature from their dorm room, had an impact on their overall happiness and academic success. This study is based on research which has shown that a view of nature decreases hospital recovery time and that interior plants in a work environment improve concentration and productivity. In order to determine how time spent with plants affects student happiness and grades, an online survey was distributed to full-time, degree seeking, undergraduate students at the Univ of Tennessee Knoxville campus. Students were asked how much time they spent doing activities that involved plants and green space through a wide range of activities from walking or riding to class to keeping houseplants. A portion of the survey targeted students which live in campus housing. These students were asked about the amount of green space that can be viewed from their windows and their satisfaction with the view. Survey questions also included major, grade point average, and the amount of time spent studying. As an incentive for taking

the survey, students were entered in a drawing to win a prize. Significantly positive survey results will be shared with campus organizations which could help improve campus green space.

*Specified Source(s) of Funding:* Univ of Tennessee Department of Plant Sciences

### **(337) Color × Phosphorus Interactions in Greenhouse-grown Annual Statice (*Limonium sinuatum* L.)**

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Reducing phosphorus inputs can be an effective method to reduce phosphorus runoff and increase profitability of crops if optimal phosphorus requirements can be determined. In order to test our hypothesis that phosphorus levels required for maximum flower production are dependent on flower color we grew white, apricot, purple, yellow, rose, and blue flowering varieties of statice (*Limonium sinuatum*) under 6 phosphorus fertilization regiments (1, 2.4, 5.8, 13.8, 33.2, and 79.6 mg-L<sup>-1</sup>P). For those yield parameters which had significant ANOVA models, stem number, total stem mass, and average stem mass, color was a significant main effect ( $P \geq 0.0062$ ). In addition a significant color x phosphorus level interaction for stem number ( $P=0.0427$ ) was observed. If the cultivar-specific trends we report here in phosphorus requirement, hold true for other statice varieties, it suggests that in protected culture, solution phosphorus fertilization could be reduced for the yellow, rose and white varieties, and for field culture, these colors could be grown on less fertile soils or with reduced fertilizer phosphorus. In either case, the economic and ecological benefit would be positive.

### **(338) Increasing Winter Salad Greens Yield in High Tunnels**

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There has been a significant increase in grower interest in supplying food for their local communities. Opportunities include CSAs, farmer's markets, farm stands and restaurants. One of the major limitations to creating sustainable local food systems in northern temperate climates, such as Utah, is growing sufficient produce during the winter months to meet market demands. High tunnel season-extension technology is one



method for providing local markets with year round produce. Previous studies have shown that row covers within tunnels can be used enhance plant growth when winter temperatures become limiting. This project evaluates the use of supplemental soil heating, different types of row covers and increased plant populations as potential methods to increase winter salad greens productivity. Smooth leaf spinach (*Spinacia oleracea* L.) and lamb's lettuce (*Valerianella locusta* L.) were transplanted on 5–6 November and left uncovered, covered with Reemay, or with low tunnels. Soil beds growing lamb's lettuce were also heated or left unheated. In a second experiment, lamb's lettuce and spinach were transplanted on 13–14 Jan. 2010 with plants spaced at 5, 10, or 15 cm apart (covered with Reemay or low tunnels). Plant were harvested every ten days and fresh weight and leaf number recorded. The use of row covers significantly increased the growth of spinach and lamb's lettuce when compared to the uncovered control. Supplemental soil heating did not increase productivity in lamb's lettuce. Decreasing plant spacing from 15 cm to 5 or 10 cm significantly increased yield (up to 48%) in both spinach and lamb's lettuce. These results suggest that row covers within high tunnels and decreasing plant spacing, are two useful strategies to increase mid-winter salad greens production in cold northern temperate production areas.

*Specified Source(s) of Funding:* Utah State Univ Undergraduate Research Award

### **(339) The Transformation of *Rubus* and Its Application to the Study of Plant Secondary Metabolites in Plant and Animal Cells**

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Transformation is the genetic alteration of a cell resulting from the uptake and expression of foreign genetic material. The ability to perform transformation is a technique that has yet to be accomplished in blackberry. To this end we use *Agrobacterium*-mediated transformation techniques to transform the blackberry (*Rubus* spp.) in tissue culture. A vector containing a GFP reporter gene was used to produce transgenic tissue. Results thus far have revealed the successful transformation of blackberry

callus and studies are ongoing. We intend to use this system to aid in the study of secondary metabolites in *Rubus*. Plant secondary metabolites provide many leads for new therapeutics in humans, however, their mechanisms of action are often not understood in either plants or animals. We hypothesize that phenolics may represent a class of plant hormones that activate developmentally-regulated signal transduction pathways that initiate or suppress cell division by mimicking small ligands. The results from this study will define the physiological role of certain phenolics in plant and mammalian cells, and potentially provide mechanisms of action for the therapeutic effects of some plant based therapeutics.

*Specified Source(s) of Funding:* AR INBRE, AR EPSCoR

Monday, August 2, 2010

Springs F & G

## **Undergraduate Poster Competition 2**

### **(340) Quantification of Postharvest Respiration Rates for Specialty Cut Greens**

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Microgreens are 7-10 day old seedlings of various vegetable crops. At harvest, seedlings are cut at root level and the product is packaged as young shoots, including only cotyledons and 3-cm long hypocotyls. Very little information is available describing the postharvest characteristics of this high value specialty crop. To expand markets of this perishable product, respiration rates must be quantified and controlled to extend shelf life. Postharvest respiration rates and visual quality were evaluated for three cool-season vegetable crop species: arugula (*Eruca sativa*), radish (*Raphanus sativus* 'China Rose'), and red cabbage (*Brassica oleracea* var. *capitata* f. *rubra*) at 4°C (control) and 10°C. Respiration rates were measured at harvest, and every 7 days thereafter, for a total of 3 weeks. Rates were quantified using a modified conifer chamber and a portable gas exchange system (LI-6400 Lincoln, NE). In addition, product quality was evaluated and quantified visually each week. Based on visual analysis, shelf-life averaged 14 days for arugula and red cabbage, and 21 days for radish when stored at 4°C. However, shelf life was reduced to seven days when stored at 10°C for red cabbage and arugula. Mean respiration rates were significantly lower at 4°C than at 10°C for all three crops. Radish mean respiration rates were 110  $\mu\text{g CO}_2 \text{ g}^{-1}\cdot\text{h}^{-1}$  at 4°C and 255 at 10°C at harvest; 1 week later mean respiration rates were 83 and 141, respectively. Arugula mean respiration rates were 101  $\mu\text{g CO}_2 \text{ g}^{-1}\cdot\text{h}^{-1}$  at 4°C and 189 at 10°C at harvest; 1 week later mean respiration rates were 83 and 167, respectively. Red

cabbage mean respiration rates  $110 \mu\text{g CO}_2 \text{ g}^{-1}\text{h}^{-1}$  at 4°C and 189 at 10°C at harvest; one week later mean respiration rates were 35 and 141, respectively. However, beginning in week 2 there was a spike in respiration rates, possibly due to decay organisms, which also corresponded to a decrease in the visual quality rating of the crop. This study provides a benchmark data set for future microgreens postharvest experiments designed to lower respiration rates and increase shelf life.

*Specified Source(s) of Funding:* Grant number 52005881 to New Mexico State Univ from the Howard Hughes Medical Institute through the Undergraduate Science Education Program and the New Mexico Department of Agriculture Specialty Crop Block grant.

### (341) Optimizing Root Formation for In Vitro Chokecherry (*Prunus virginiana*)

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Chokecherry (*Prunus virginiana* L.) is a native North American plant that has potential as a regionally important alternative fruit crop. Several fruiting types have been selected but are proving difficult to propagate. These selections are growing successfully in stage II tissue culture, but *ex vitro* establishment has been problematic. Plantlets were subjected to one of a combination of *in vitro* and *ex vitro* conditioning treatments including short and prolonged exposure to auxins (3 mg/L NAA or 3 mg/L IBA) or etiolation, and then evaluated for root formation and *ex vitro* survival. Plantlets transferred directly from stage II media to potting soil and placed under intermittent mist had an establishment rate of 40.6%. Hormone treatments and etiolation both resulted in reduced establishment and survival. Interestingly, some plantlets left on stage II media without transferring to fresh media for 12 to 15 weeks showed rooting percentages of 47.2%. More work is needed to increase rooting percentage and initial survival in order for clonal propagation of these fruiting chokecherry selections to be commercially viable.

*Specified Source(s) of Funding:* USU Undergraduate Research and Creative Opportunities grant

### (342) Use of Gibberellic Acid Inhibitors for Control of Annual Bluegrass (*Poa annua* L.) in Creeping Bentgrass (*Agrostis palustris* Huds.) Putting Greens

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Annual Bluegrass (*Poa annua* L.) has become a major problem for temperate zone golf courses, particularly on putting greens. Because *P. annua* is so invasive and difficult to control, it often becomes a substantial percentage of the stand, resulting in the need for increased amounts of water and pesticides. In this study, three plant growth regulators (PGRs), specifically the gibberellic acid inhibitors flurprimidol, paclobutrazol, and trinexapac-ethyl, were used in a variety of combinations and rates to find an effective *P. annua* control that also minimized turf injury. Creeping bentgrass (*Agrostis palustris* Huds.) plugs containing an average of 20.6% established *P. annua* were removed from a putting green and potted in 2.6 L plastic containers. The turf was maintained in the greenhouse under a 16 hr photoperiod and mowed daily to a height of 0.5 cm. Eleven treatments were applied at 14 day intervals over a 15 week period, with measurements of percent *P. annua* and visual ratings of turf injury taken preceding each application. The combination of paclobutrazol and trinexapac-ethyl at the rates of 45.4 and 10.6 g active ingredient (a.i.) per acre, respectively, provided the most effective control. This treatment reduced *P. annua* by an average of 71.9% and also resulted in the lowest turf injury of any PGR treatment. Three other treatments, paclobutrazol and flurprimidol at 45.4 and 56.7 g a.i. per acre, trinexapac-ethyl and flurprimidol at 10.6 and 56.7 g a.i. per acre, and paclobutrazol, trinexapac-ethyl and flurprimidol at 79.8, 15.9 and 70.9 g a.i. per acre, produced statistically similar reductions in *P. annua*, with only the last of these three treatments showing significantly more turf injury. The highest rates of turf injury were observed in treatments containing all three PGRs at the highest application rates. These results indicate that the combination of paclobutrazol and trinexapac-ethyl may provide effective control of *P. annua* on golf putting greens.

*Specified Source(s) of Funding:* ASHS Travel Grant

### (343) In Vitro Propagation of *Stevia rebaudiana*

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*Stevia rebaudiana* is a tropical plant in the Asteraceae family. The leaves of this plant contain a compound important in producing low calorie sweeteners for the food industry. Establishing an efficient micro propagation technique is economically important because plant production from seed is slow and unreliable. The photoperiodic nature of the crop stops vegetative growth when daylight is less than 12 hours. Explants for this experiment were obtained from field grown *Stevia* plants at the end of the growing season. Explants were rinsed for 10 minutes under flowing tap water to remove debris then submerged in 10%

bleach (sodium hypochlorite) solution for 20 minutes. Two or three nodal cuttings were transferred to MS media (1962). About fifty percent of the cultures were contaminated with mold. Among the uncontaminated cultures growth of explants were observed after four weeks on media. After six weeks on establishment media, plants were removed and sectioned into two node cuttings and placed on MS media supplemented with 6-benzylaminopurine (BA). More lateral shoots were produced on the BA supplemented media than on the control. An average of three extra shoots was produced per explants. The acclimation phase included transferring plants from tissue culture to a small chamber to maintain a high humidity. Plants were transitioned to ambient environment over a 14 day period.

*Specified Source(s) of Funding:* Undetermined

### **(344) Investigating the Functional Roles of Genes Involved in Early, Middle, and Late *Rubus* Prickle Development**

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Prickles are outgrowths of epidermal and sometimes cortical plant tissue that develop from a signaling cascade initiated by the head of glandular trichomes. These signals result in the division and growth of epidermal and underlying cortical cells. Due to the simplicity of their structure, prickle development is an ideal model to investigate how cells communicate to control growth, proliferation, and morphological differentiation. Understanding these modes of cellular communication could lead to significant insights to all developmental pathways including those in mammals. We are currently analyzing gene candidates and their

function in prickle development to better understand the role of trichomes in prickle development. To this end, we hypothesize that lignification marks the end of prickle development. *PAL 1* and *PAL 2* are known to play a role in the lignification pathway, and have been targeted for functional analysis in this study due to their potential as stop signals in prickle development. We have also hypothesized that *GLI* and *GIS* are involved in promoting early trichome and thus prickle initiation in *Rubus*. *SIM* is hypothesized to also play a significant role in endoreduplication and subsequent trichome development. To this end, we are currently identifying orthologous ESTs (expressed sequence tags) from the trichome developmental pathway of *Arabidopsis*, *Fragaria*, and *Medicago* using a degenerate primer method. We have thus far identified several genes from *Rubus*, our prickle development model plant. Using these orthologous EST sequences we are carrying out functional analysis using *in situ* hybridization (ISH). One complicating factor is sectioning tissue at the exact point of the occurrence of a glandular trichome is difficult; therefore, we have initiated the investigation of whole mount ISH allowing us to look at the entire epidermal surface of the tissue rather than sections. Together, these data will provide insight as to the potential signaling pathways involved in prickle development.

*Specified Source(s) of Funding:* USDA Seed Grant

### **(345) Effect of Vernalization and Photoperiod on Flowering of Summer-flowering *Chrysanthemum***

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*Chrysanthemum ×morifolium* 'Qiyuetaohua' is a ground-cover cultivar characterized by flowering in early summer in Beijing, China. To identify the photoperiod response type and effectively utilize the early flowering trait, vernalization

and photoperiod requirement for flower bud initiation and development were investigated, as measured by the days to the appearance of the bud and the terminal flower. All rooted cuttings were obtained from stock plants maintained in a vegetative state with long day (LD=14 to 16h photoperiod plus night interruption lighting, 2200 to 0200HR, using 400W incandescent lamps) and 24°C/20°C (day/night) temperatures. After rooting in sand for ten days with the same conditions as the stock plants, the treated rooted cuttings were vernalized for four weeks at temperature 3-7°C under LD condition and then transferred to three photoperiod treatments: short days (SD=black cloth pulled 0800/1600HR, providing 16h darkness), LD, natural day lengths during March to July at Beijing, China under greenhouse conditions with same temperature as stock plants. All summer-flowering 'Qiyuetaohua' treated by low temperature initiated flower buds and developed to anthesis at three photoperiod treatments. The mean days to flower bud initiation and development for vernalized plants at LD were 90 and 110 days, respectively, which showed 5 and 8 days earlier than that at SD. The mean days to flower bud initiation and development for vernalized plants at ND were 94 and 116 days respectively. However, the controlled plants (no vernalization) never developed any flower at any photoperiod treatments and remain vegetative for treated time. The results indicated that *Chrysanthemum × morifolium* 'Qiyuetaohua' is a day-neutral plant after vernalization and the early flowering phenotype under natural conditions could be attributed to low temperature at seedling stage.

*Specified Source(s) of Funding:* Supported by National Key Technology R & D Program in Eleventh Five-Year Plan of China (2006BAD13B07) and National "863 Program" (2008AA10Z156)

### **(346) Construction of Forward and Reverse Subtracted cDNA Libraries from *Opisthobappus taihangensis* (Ling) C. Shih. under Drought Stress**

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*Opisthobappus taihangensis* (Ling) C. Shih. grows vigorously in both arid and saline soils, which indicates its strong resistance to drought stress. To study the molecular mechanisms of drought-stress resistance and obtain differential expressed genes in *O. taihangensis*, suppression subtractive hybridization (SSH) was employed in this study. Forward and reverse subtracted cDNA libraries were constructed with leaves treated by PEG solution. Results of electrophoresis suggested noticeable differences in PCR bands between subtracted sample and non-subtracted sample, which indicated that the subtraction was effective. In the subtracted cDNA library, the recombination rate was 92%, with the size of inserts between 200-600bp. Through sequencing the partial clones of forward subtracted cDNA libraries, a number of genes related to drought resistance were obtained and verified with Northern hybridization, such as bZIP transcription factor, MADS-box protein, SOD, calcium-dependent protein kinase genes etc. The results provided important information for cloning new genes from *O. taihangensis* and led to further study of molecular mechanism related to drought resistance.

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Monday, August 2, 2010

Springs F & G

## **Genetics/Germplasm/Plant Breeding: Cross-Commodity**

### **(049) Effects of Planting Date and Stand Density on Sugar and Ethanol Yields of Sweet Sorghum Grown in Arizona**

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Sweet sorghum [*Sorghum bicolor* (L.) Moench] is currently being investigated as a direct feedstock for biofuel production in the semi-arid Southwest US. Previous studies in Arizona have shown that the plants can be grown with fewer inputs, e.g. water and nitrogen, than other biofuels crops. Since the juice in the stems can be directly fermented, a further energy savings is realized. The need for specific information for growers on optimal date of planting and stand density prompted the current research. Four commercial varieties (Dale, M81E, Theis, and Topper) were each sown on four dates (April, May, June, and July 2008) and harvested at physiological maturity. In 2009, three varieties (Cowley, M81E, and Topper) were each planted at five densities (2.5, 4, 6.7, 10, and 20 plants per meter). All treatments of each line were harvested at maturity; in addition, juice samples were analyzed for sugars on a semi-weekly basis. To obtain field weights, two 6.1-m sections from the middle two rows of each four-row plot were cut and weighed. A 15-stalk subsample was weighed, stripped of leaves and panicles, and re-weighed to calculate percent stalk. In 2009, stem diameters were also measured. Stems were passed through a roller mill, and the resulting liquid weighed. Juice samples were analyzed by HPLC with refractive index detection for fructose, glucose, and sucrose. Predicted ethanol was calculated using a formula developed previously. In 2008, Dale and Theis matured faster, and all lines planted earlier took longer to reach harvest. Total sugar yield was higher in the May and June plantings, while the April and May plantings had the highest predicted ethanol.

Results from 2009 highlight interactions between line and density, suggesting that certain lines may be less susceptible to competition. Lower densities (2.5, 4, and 6.7 plants per meter) generally produced plants that were taller, thicker, and heavier, and contained more juice. As in previous years, more biomass and juice were better predictors of ethanol yield than other factors. Sugar accumulation over time demonstrates near constant levels of monosaccharides, while sucrose increases up to and after harvest. Sweet sorghum may play a transitory role in the biofuels industry in Arizona. For the lines studied, planting in May is preferred, at a density of 4 to 6.7 plants per meter. Since many of the plots planted in June and July germinated poorly, these dates are not recommended.

*Specified Source(s) of Funding:* Sun Grant

### (050) Heritability Estimates of Native Prairie Junegrass Breeding Material

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Prairie junegrass [*Koeleria macrantha* (Ledeb.) Shultes] is a perennial, short-grass prairie species distributed throughout the Northern Hemisphere. This species is known to require fewer inputs than other cool-season turfgrasses and it demonstrates tolerance to many environmental stresses found in Minnesota. In June 2007, 300 genotypes derived from Colorado, Nebraska,

and Minnesota germplasm were grown and evaluated for turf quality characteristics in 2 locations (St. Paul, MN and Becker, MN). Following establishment, plots received no supplemental irrigation or fertility and were mowed weekly to a height of 6.4 cm. Data were collected for three growing seasons on turfgrass quality traits and its components including crown density, mowing quality, and color. Data were also collected on rust (incidence and severity), spring green-up, plant height, lateral spread, fall color, and flowering traits (inflorescence emergence and the persistence of straw after mowing). Broad-sense heritability estimates were calculated on a clonal mean (Hc) and single plant (Hsp) basis for turf quality (Hc = 0.62, Hsp = 0.13), crown density (Hc = 0.55, Hsp = 0.09), mowing quality (Hc = 0.59, Hsp = 0.09), and genetic color (Hc=0.45, Hsp = 0.06). The heritability estimates indicate that selection for these traits should result in significant gains in germplasm improvement. The positive correlations among several of these traits will allow for simultaneous multi-trait selection. *Specified Source(s) of Funding:* Grant-in-Aid from Univ of Minnesota Graduate School, the United States Golf Associate Green Section, and the USDA ARS.

### (051) A Three-year Sensory Fruit Quality Study in a Group of New Tangerine Hybrids

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Florida tangerine (*Citrus reticulata* Blanco) production accounts for 40-50 % of the US production, and is the third largest of all citrus fruit, following oranges and grapefruits. A number of tangerine selections from the Univ of Florida CREC breeding program were evaluated for fruit juice quality over three consecutive harvest seasons. In the first year, 45 tangerine hybrids and 10 named commercial cultivars were sampled from November 2006 to March 2007. Some samples were harvested multiple times over the season. Fruit were washed, sanitized, and carefully juiced by hand to avoid incorporating peel oil volatiles into the samples. Juice was frozen for later analysis of volatiles, titratable acidity (TA), soluble solid concentration (SSC), sugars and acids analyses as well as for sensory evaluation. In the sec-

ond year (2007-2008 harvesting season), 12 of the 45 tangerine hybrids evaluated previously were selected for re-evaluation, along with five named commercial cultivars as references, and eight new hybrids. In the third year (2008-2009), many of the same hybrids and named cultivars as in the first and/or second year were re-evaluated. A 15-member taste panel was trained for 24+ hours to describe aroma and flavor of tangerine juice, and a core of nine panelists participated during the full 3-year study. Flavor profiles varied widely among all hybrids, and also within individual hybrids harvested at varying points within the maturity season, and between years. Hybrids with sweet orange in their background were specifically described with orange and floral aroma/flavor ('Ortanique' tangor), or sour with grapefruit-like or "fresh" aroma and flavor ('Temple' tangor, 'Sanguinelli' blood orange, '8-9' × 'Val4x'). Other hybrids exhibited high sweetness and a characteristic "fruity-non-citrus" or "pumpkin" and "cooked" aroma/flavor ('Fallglo', crosses from 'Robinson' × 'Fairchild', 'Fallglo' × 'Faichild', and one hybrid of unknown parentage). Some selections had "sulfury", "fatty" and "bitter" aroma and flavor, possibly due to delayed bitterness that is developed after juicing and in storage ('Murcott LS', '8-9' × 'Murcott'). For some hybrids, flavor and aroma greatly varied with harvesting season and/or maturity at harvest (crosses from '8-9' × 'Murcott' and '8-9' × 'Orlando'). There was no typical "tangerine" aroma or flavor detected in the juice by panelists. As it is peel oil that gives a typical tangerine aroma to whole fruit, and hand juicing carefully excluded oil from the juice, this was not unexpected.

### **(052) Effects of Anthropogenic Activities on Genetic Diversity of American Ginseng Growing in West Virginia**

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Genetic variation and structure of 12 wild and 10 cultivated populations of American ginseng growing under two levels of harvest pressure and cultivation intensity in West Virginia was assessed using random amplified polymorphic DNA (RAPD) markers. Eight primers used generated a total of 98 discernable and reproducible bands of which 84 (85.71%) bands were polymorphic. Mean genetic diversity indices were high in wild populations from low harvest pressure region [percent polymorphism (P) = 33.33%, Nei's (1973) gene diversity (H) = 0.1172, and Shannon's index (I) = 0.1743] compared to populations from high harvest pressure region [P = 28.27%, H = 0.1019, I = 0.1513], however diversity measures were not significantly different (P > 0.05, Mann-Whitney test). Analysis of molecular variance (AMOVA) further showed no significant genetic differentiation among regions (P = 0.7918), but genetic differentiation within populations (48.37%) and among populations (54.10%) were significant (P < 0.001). With regard to cultivation intensity, populations from

a region with low cultivation intensity showed lower levels of genetic diversity (P = 29.93%, H = 0.0948, I = 0.1609) compared to populations from a region with high cultivation intensity (P = 60.60%, H = 0.2593, I = 0.3243), these diversity measures were significantly different (P < 0.05, Mann-Whitney test). AMOVA further revealed that, in cultivated populations 53.68% and 42.11% of the total genetic variation was attributed to within and among population differentiation in regions respectively, and a small (4.20%) but significant variation was found among regions. Differences in genetic diversity indices between wild populations from the two regions indicate that harvesting pressure may reduce genetic diversity of ginseng populations, although Mann-Whitney test and AMOVA did not indicate significant variation among these harvesting regions. Significantly higher population genetic diversity evidenced in cultivated populations from a region with high cultivation intensity can be attributed to large scale growers sourcing seeds from a broad seed source to meet their cultivation scale. Whereas, lower diversity levels among populations in regions with less cultivation intensity will be due to small scale growers probably starting their crop from a narrow seed source, mostly from seeds collected from a single population in the wild or purchased from a single source. Key words: AMOVA, cultivation intensity, harvest pressure, Panax quinquefolius, RAPD.

*Specified Source(s) of Funding:* USDA NIFA HATCH

### **(053) Variation in Anthocyanin Content of Wild Black Raspberry for Breeding Improved Cultivars**

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Because of its intense anthocyanin pigments, black raspberry (*Rubus occidentalis* L.) has a long history of use as a natural colorant and dye. Recent studies showing black raspberries to be a rich source of anthocyanins and other dietary phytochemicals have led to renewed interest in breeding better adapted cultivars that meet the demands of these markets. Because of this, anthocyanin content is a critical indicator of fruit quality for processed markets. While previous studies characterizing black raspberry anthocyanins have focused on existing cultivars comprising a narrow genetic base, progress in breeding new cultivars will rely on the use of new germplasm sources. Using high performance liquid chromatography/diode array detector/ion trap mass spectrometer, we examined anthocyanin content and profiles in the juice of fruit from black raspberry seedlings representing 78 wild populations from across the species' native range. Anthocyanin profiles were similar to those previously

reported, however total anthocyanin content varied widely, with individual clones ranging from less than one fourth to nearly three times the anthocyanin concentration of the industry standard, 'Munger'. Genetic diversity for anthocyanin content is present in recently collected wild black raspberry germplasm and should be carefully evaluated when using this material for breeding improved cultivars.

#### **(054) Principal Component Analysis for Morphological, Seed Reproductive, and Phenology Traits in 16 Sunn Hemp (*Crotalaria juncea* L.) Accessions**

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Sunn hemp, *Crotalaria juncea* L. is a tropical legume grown for fiber, cover cropping, and as a green manure crop with potential to contribute to sustainability. Sixteen sunn hemp accessions were grown in the southeast U.S. from 2008 to 2009 and characterized for horticultural traits including biomass, foliage, plant size, flowering, and seed reproductive traits. Principal component analysis were applied to all traits for characterizing relationships among sunn hemp accessions for primary and secondary branches, open flowers, leaves, nodes, internodes, and seeds as well as diverse plant height, width, leaf area, apical dominance, and seed weight. The first three principal components had eigenvalues greater than 1.00, and together they explained 84% of the total variation occurring between these 16 sunn hemp accessions for this group of morphological, phenological, and reproductive traits. Apical dominance, flowering, seed number, total seed weight, open flowers, primary lateral branches, and nodes contributed mostly towards total variance in these sunn hemp populations. Cluster analysis separated sunn hemp accessions into two groups (clusters) based on low or high seed numbers. Sunn hemp accessions could be used as parents for hybridization and thus contribute to sunn hemp breeding.

*Specified Source(s) of Funding:* SARE grant

#### **(055) New Clonal Emphasis for the Arctic and Sub-arctic Plant Genetic Resources Unit in Palmer, Alaska**

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The U.S. Department of Agriculture–Agricultural Research Service (USDA/ARS) Arctic and Sub-arctic Plant Genetic Resources Unit (ASPGRU) was established in 2001 and was recently realigned with the USDA/ARS National Clonal Germplasm Repository in Corvallis, OR. ASPGRU is now one of the clonal genebanks of the National Plant Germplasm System (NPGS) and works in collaboration with the Univ of Alaska–Fairbanks, School of Natural Resources and Agricultural Sciences at the Matanuska Experiment Farm in Palmer, AK. This genebank now has a primary focus on four clonal genera—*Mentha*, *Paeonia*, *Ribes*, *Rheum*—in addition to about 20 others of horticultural, agronomic or reclamation interest to the circumpolar region. These plants are adapted to short cool seasons and a long photoperiod. The goals of this unit are to conserve, evaluate, and distribute these plants and to generate and manage associated information. This unit will provide scientific support for crop improvement and production in the arctic region. The ASPGRU collection contains about 29 genera and 112 species. The *Mentha* collection is established as greenhouse plants. Field demonstration gardens will be established during summer plantings. The collection is presently expanding to include *Peonia* and some arctic and sub-arctic small fruits. The *Ribes*, *Rheum*, and *Paeonia* collections will be maintained in the field with backup plants in the greenhouse. Plants will be monitored for plant pathogens using serological methods (western analysis and enzyme-linked immunosorbent assays) and molecular techniques (polymerase chain reaction and sequencing) for definitive identification. A combination of heat therapy and tissue micropropagation will be utilized to establish and maintain healthy plants for distribution. Studies will begin examining plant phenology and adaptation related to global climate change. Information on ASPGRU germplasm can be found via the NPGS Germplasm Resources Information Network (GRIN; <http://www.ars-grin.gov/npgs>).

*Specified Source(s) of Funding:* Visa card

#### **(056) The USDA/ARS Rhubarb Collection**

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The U.S. Department of Agriculture/Agricultural Research Service's (USDA/ARS) National Plant Germplasm System (NPGS) is directed to acquire, characterize, preserve, document, and distribute plant germplasm important for food and agricultural production. The Arctic and Sub-arctic Plant Genetic Resources Unit of the USDA/ARS, in association with National Clonal Germplasm Repository in Corvallis, OR, is housed at the Univ of Alaska – Fairbanks Matanuska Experiment Farm in Palmer, AK. The Palmer site is the primary rhubarb (*Rheum* L.) repository for the NPGS and consists of 3 species and 66

accessions. Information on ASPGRU rhubarb germplasm can be found via the NGPS Germplasm Resources Information Network (GRIN; <http://www.ars-grin.gov/npgs>). The Western Regional Plant Introduction System in Pullman, WA acts as the backup site for the rhubarb collection. The collection is maintained clonally at a spacing of 1.8 m between rows and 1.8 m between plants. Soil is tilled in the spring and weeded regularly throughout the season. Irrigation is applied as needed via overhead sprinkler irrigation. Pesticides are also applied as needed. Seed stalks are removed as they appear to avoid cross-pollination and seed set. The collection is screened annually for Turnip Mosaic Virus (TuMV) using indirect enzyme-linked immunosorbent assay (ELISA) and western blots with a monoclonal antibody specific to the potyvirus group. Any diseased plants are removed from the collection and discarded. In the late fall, winter preparation includes the removal of vegetative matter from the plants. Accessions of the ASPGRU rhubarb collection are available for research purposes. Crowns can be divided and distributed in the spring just after foliation begins (May/June) or fall prior to dormancy (September/October). Requests for limited propagation material for research can be made via GRIN.

*Specified Source(s) of Funding:* Visa card

**Monday, August 2, 2010** **Springs F & G**

## Genetics/Germplasm/Plant Breeding: Vegetable Crops 1

### (035) Genomic DNA Diversity in Tomato Varieties Revealed by Indel and SSR Markers

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The emergency of intronic and genomic sequences in tomato (*Solanum lycopersicum* L.) provides a base for developing indel markers. Some of them have been discovered to date. However, whether these markers can be used in tomato molecular breeding remains unclear. Therefore, indel and SSR markers were used to analyze genomic DNA diversity in 59 fresh-market tomato varieties growing in China to investigate the potential of indel markers in tomato molecular breeding. Comparison between 59 Chinese varieties and 23 US varieties were also conducted at

marker level. The results indicated that the indel marker showed lower polymorphisms in varieties with narrowed genetic basis, suggesting that they were not suitable to detect polymorphisms in this kind of tomato lines. At the same time, we also found that both indel and SSR markers showed lower polymorphisms in Chinese varieties than in US varieties. Genetic difference was very small between varieties developed by Chinese breeding programs but relatively larger between Chinese and foreign varieties.

### (036) Genetic Diversity of Watermelon Germplasm Revealed by SSR Marker

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Plant Introduction constitutes one of the most important approaches for plant breeding, especially on watermelon, as there is little evidence on watermelon origination in China. Besides watermelon production plays an economically important role in China for farmers. However, the success of watermelon domestication pattern is determined by its ecotype and genetic characteristics. Therefore, in this experiment, both of the genetic diversity and relatedness on watermelon grouped by ecotypes were examined using 96 watermelon cultivars, landraces, lines, hybrids and wild types collected from China, Japan, Russia as well as America respectively based on SSR markers. Total of 38 pairs of primer with polymorphism were chosen from 398 SSR markers and produced 139 loci with 69 polymorphic loci (49.6%) as well as 1.8 polymorphic loci on average. Jaccard's similarity coefficient (JC) which was demonstrated by pairwise comparisons of genotypes ranged from 0.42 to 0.99. A dendrogram was constructed using the Unweighted Pair Group Method with Arithmetic averages (UPGMA) in computer program NTSYSpc Version 2.02i. 96 watermelon genotypes were classified into VII groups at similarity coefficient of 0.74 by ecotypes according to the Cluster Analysis. Group I comprised 35 watermelon germplasm from Northern area of China which have types of intermediate maturity periods and low level soluble solids content as well as mushy flesh texture. Group II contained 2 watermelon germplasm from Northwestern and 8 watermelon germplasm from the southern area of China with large fruit size and thick rind. Group III included 2 types of vegetable watermelon germplasm, featuring large seeds size, white flesh and low soluble solids content. Group IV included all watermelon germplasm from Northwestern area of China which performed to be thick in rind, long on maturity period



and high with soluble solids content. Group V consisted 3 different types of watermelon germplasm from Japan, Russia and America while 2 semi-wild types were grouped into the sixth cluster. The wild type watermelon germplasm formed a distinct cluster. These results indicated consensus with the geographical distribution of watermelon germplasm in China on the basis of SSR markers. The exception was that watermelon from the northwestern and northern areas of China was grouped in the same cluster. Watermelon germplasm from different countries (Japan, Russia, and America) were also classified into the same group. But all these results further suggested that the narrow genetic basis of watermelon and all watermelon germplasm collected from China will have benefit to broaden the materials of watermelon in genetic breeding.

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### (037) Physiological Races Identification of Powdery Mildew on Cucurbits in Heilongjiang Province

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Powdery mildew is one of the most important diseases attacking cucurbits in greenhouses and open-field. The disease can be caused by three fungal species, *Sphaerotheca fuliginea*, *Erysiphe cichoracearum* and *Leveillula taurica*, but *S. fuliginea* is the most commonly species in China. The powdery mildew physiological races infected cucurbits change quickly. Consequently, knowledge on the prevalence and geographic distribution of these races is essential for the choice of appropriate strains to be used in breeding programs and for the implementation of gene deployment strategies. Eighteen powdery mildew samples were isolated from mildewed melon, cucumber, pumpkin and squash grown in greenhouse or open field of seven different ecological regions in Heilongjiang Province in 2009, then were detected using the standard identification system of powdery mildew. According to performance on thirteen hosts which are universal in the world, one strain came from cucumber of Mudanjiang was classified as race N1, while others were race 1. This study preliminarily confirmed that race 1 of *Sphaerotheca fuliginea* was the dominant race which infected cucurbits. It also provided basis for cucurbits resistance variety breeding in Heilongjiang.

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### (038) Evaluation of *Cucurbita moschata* Accessions for Crown Rot Resistance to Floridian Isolates of *Phytophthora capsici*

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*Phytophthora capsici* causes several disease syndromes on squash and pumpkins (*Cucurbita* spp.) including crown rot, foliar blight and fruit rot, which can cause yield loss as high as 100%. Currently, there are no *Cucurbita* cultivars with resistance or tolerance to this pathogen. The objective of this study was to evaluate a select group of *C. moschata* accessions, from the USDA germplasm collection, for sources of resistance or tolerance to crown rot caused by *P. capsici*. A collection of 119 *C. moschata* accessions, representing 39 diverse geographic locations, were evaluated for response to inoculation with a suspension of three highly virulent *P. capsici* isolates from Florida. Eight plants per accession along with a susceptible control were inoculated at their crown with a 5-mL *P. capsici* suspension of  $2 \times 10^4$  zoospores/mL. Twenty-one days post-inoculation, the plants were visually rated on a scale ranging from 0 (no symptoms) to 5 (plant death). Mean disease rating scores (DRS) of the *C. moschata* collection ranged from 1.4 to 5. Accessions with low, intermediate, and high mean DRS were rescreened. Potential sources of resistance or tolerance were identified in the *C. moschata* collection. PI 458740, PI 442266, PI 442262, and PI 634693 with a mean DRS <1.0 were the most promising. Selections from these accessions can be made to develop *Cucurbita* breeding lines and cultivars with resistance or tolerance to crown rot caused by *P. capsici*.

*Specified Source(s) of Funding:* Univ of Florida

### (039) PA-560, a Root-knot Nematode Resistant, Yellow-fruited, Habanero-type Pepper

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Efforts to develop a yellow-fruited, Habanero-type pepper (*Capsicum chinense* Jacq.) that is highly resistant to root-knot nematodes were completed with the official release of PA-560 on 20 Oct. 2009. PA-560, an advanced breeding line, is the product of a backcross/pedigree breeding procedure to incorporate a root-knot nematode resistance gene from the Scotch Bonnet-type accession PA-426 into a yellow-fruited, Habanero-type pepper. PA-560 was derived from a single F3 (BC4F3 x

BC4F3) plant grown in 2005. It is homozygous for a dominant gene conditioning a high level of resistance to the southern root-knot nematode [*Meloidogyne incognita* (Chitwood) Kofoid and White], the peanut root-knot nematode [*M. arenaria* (Neal) Chitwood], and the tropical root-knot nematode [*M. javanica* (Treub) Chitwood]. PA-560 has a compact plant habit and produces a lantern-shaped, yellow-colored fruit. The results of replicated field studies conducted at Charleston, SC, indicate the yield potential of PA-560 is comparable to that of traditional Habanero-type cultigens. A typical fruit weighs about 7.6 - 8.0 g and is 2.37 - 2.49 cm wide x 4.43 - 5.54 cm long; the fruit wall is thin (1.43 - 1.60 mm). The fruits are extremely pungent (326,710 Scoville heat units), and a typical fruit has three locules (average number of locules: 3.3). The root-knot nematode resistant PA-560 is recommended for use as a parental line by pepper breeders interested in developing yellow-fruited, root-knot nematode resistant cultivars of Habanero-type peppers. The dominant nature of the gene conditioning the root-knot nematode resistance trait would make PA-560 useful as an inbred parent for development of root-knot nematode resistant F1 hybrids.

#### (040) Truhart-NR, a Root-knot Nematode Resistant, Pimento-type Pepper Cultivar

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Efforts to develop a high-yielding, pimento-type pepper (*Capsicum annuum* L.) cultivar that is highly resistant to root-knot nematodes were completed with the official release of Truhart-NR on 20 Oct. 2009. The new cultivar is homozygous for the dominant *N* gene that conditions a high level of resistance to the southern root-knot nematode [*Meloidogyne incognita* (Chitwood) Kofoid and White], the peanut root-knot nematode [*M. arenaria* (Neal) Chitwood], and the tropical root-knot nematode [*M. javanica* (Treub) Chitwood]. Truhart-NR was developed as a replacement for Truhart Perfection, a widely-adapted and long popular pimento-type cultivar that is highly susceptible to root-knot nematodes. A backcross breeding procedure was used to incorporate the dominant resistance gene into a Truhart Perfection genetic background. The donor parent of the resistance gene was Mississippi Nemaheart and the recurrent parent was Truhart Perfection. Mississippi Nemaheart is the product of a recurrent backcross breeding program that utilized Truhart Perfection as the recurrent parent, but it was never utilized widely by industry because it was considered by many to produce a weak plant. Truhart-NR was derived from a single BC2F3 plant grown in 2006. Truhart-NR is quite similar in appearance and maturity to Truhart Perfection. It has an erect plant habit and produces heart-shaped, dark red fruit. The results of replicated field studies indicate that the fruit and yield characteristics of Truhart-NR are superior to those of Truhart Perfection. Over a two year period, Truhart-NR yielded an average of 16.7% more

marketable fruit than did Truhart Perfection (15,116 kg/ha vs. 12,957 kg/ha, respectively). Truhart-NR fruit were also 6.9% heavier, 6.2% longer, and exhibited 4.3% thicker fruit walls. A typical Truhart-NR fruit has three locules, weighs 67.8 g, is 5.64 cm wide x 7.36 cm long, and has 4.41 mm thick fruit walls. The root-knot nematode resistant Truhart-NR is particularly recommended for use by organic farmers and growers of specialty crops because these segments of the pepper industry do not have easy access to alternative production sites or the needed nematicides and nematicide application equipment. Truhart-NR should perform well in all areas where Truhart Perfection has been grown successfully.

#### (041) Molecular Mapping of QTL for Sugars in Melon

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Sucrose, fructose, glucose, and total sugars (TS) are major factors determining mature melon (*Cucumis melo* L.) fruit sweetness. The ratio of individual sugar compositions is also an important fruit sweetness trait. Molecular markers linked to genes regulating synthesis of sugar components may improve the breeder's ability to recover high sugar genotypes and aid in the development of high sugar cultivars. Our objective was to identify molecular markers linked to quantitative trait loci (QTL) for sucrose, fructose, glucose, three individual sugar ratios, TS, and total soluble solids (TSS) in a genetic linkage map by means of an F2 population from the 'Deltex' (high TS) x TGR 1551 (low TS) cross. The parents and F2 plants were grown in two separate greenhouse and field experiments. Continuous frequency distributions for eight sugar traits were observed in greenhouse and field populations indicating quantitative inheritance for the traits. Sucrose was positively correlated with TS and TSS, whereas it was negatively correlated with fructose and glucose. Of 350 markers on the linkage map, 115 were significantly associated with at least one of the eight sugar traits in the greenhouse population based on simple linear regression. Eight QTL affecting sucrose were found on linkage groups (LGs) 4, 5, 6, 7, 8, and 9. Six QTL on different LGs were significant in a stepwise multiple regression (SMR) analysis where the full

model explained 30% of the total variation for sucrose. We detected 12 QTL for each of two individual sugar components, fructose and glucose, on the map. The SMR analysis indicated that eight and six QTL accounted for 41% and 42% of the total fructose and glucose variation, respectively. Nine QTL for TS were observed on LGs 1, 4, 6, 7, 8, and 9. Markers associated with five QTL on LGs 4, 6, 8, and 9 were significant in the SMR, and explained 31% of the total variation for TS. Regions on LGs 1, 2, 4, 5, 6, 7, and 8 were related to four or more sugar traits, and confirmed in the field population. This suggests that in this cross, sugar traits are controlled partially by the same QTL. We identified common sugar QTL on LGs 2, 3, 4, 6, and 11 derived from 'Deltex' and 'Dulce' and unique sugar QTL derived only from 'Deltex'. These markers linked to the sugar synthesis QTL could be useful in melon breeding for improving the mature fruit sweetness.

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#### **(042) Construction of a RAPD and SSR-based Linkage Map in Winter Squash (*Cucurbita moschata*)**

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We constructed a randomly amplified polymorphic DNA (RAPD) and simple sequence repeat (SSR) based linkage map in *Cucurbita moschata* ( $2n=2x=40$ ) from an  $F_2$  population of 90 individuals derived from an intra-specific cross between the U.S. cultivar 'Butterbush' and a French heirloom variety 'Sucrine DuBerry.' Three hundred nineteen polymorphic loci were identified from 1200 RAPD markers. Of the 240 SSR markers derived from *C. moschata* genomic DNA, 36 (15%) did not amplify but only 27 (11%) were polymorphic. Of the 193 SSR markers derived from *Cucurbita pepo* genomic DNA, 60 (31%) did not amplify but only 8 (4%) were polymorphic. The low level of polymorphism illustrates the high level of inbreeding present among *C. moschata* germplasm. Of these, 270 loci (239 RAPD and 31 SSR), were used for linkage map construction. Linkage groups were constructed using Kosambi's mapping function in JoinMap 3.0 with a LOD score threshold of 3.0 and REC threshold of 0.45. A total of 24 linkage groups were obtained with a total map length of 1109.1 cM, and averages of 46.2 cM per linkage group and 4.1 cM between markers. The creation of this linkage map in *C. moschata* will be used in future quantitative trait loci (QTL) studies to map regions of the genome associated with mesocarp coloration.

*Specified Source(s) of Funding:* Univ of Florida

#### **(043) QTL Associated with Resistance to Bacterial Spot Race T4 in Tomato**

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Resistance to bacterial spot (*Xanthomonas perforans*) race T4 has been characterized in Florida tomato (*Solanum lycopersicum*) breeding lines Fla. 8517, Fla. 8233 and Fla. 8326. F2 populations derived from crosses between each of these lines and one or both of the susceptible breeding lines Fla. 7946 and Fla. 8111 were evaluated in Fall 2008 and Fall 2009 to confirm and quantify effects of previously identified QTL. A chromosome 11 QTL derived from Hawaii 7998, which is in the pedigree of each resistant line, was confirmed in all populations as a major contributor to resistance. This locus appears distinct from the bacterial spot race T3 hypersensitivity gene Rx-4, that was recently mapped to chromosome 11. A marker linked to the I-3 gene on chromosome 7, which confers resistance to Fusarium wilt race 3 (*Fusarium oxysporum* Schlecht. f. sp. *lycopersici* Snyder & Hansen), was strongly associated with susceptibility to bacterial spot race T4 in all populations involving Fla. 7946—the only line containing I-3. In the Fla. 8517 population, two QTL on chromosomes 3 and 12 contributed minor effects towards resistance and susceptibility, respectively.

Monday, August 2, 2010

Springs F & G

### **Horticultural Crops Culture and Management: Cross-Commodity**

#### **(242) Effects of Photoperiod on Liner and Budded Tree Growth in Containerized Citrus Nurseries**

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As per the new legislation in Florida, citrus nursery trees now must be grown in greenhouses to protect them from the Asian Citrus Psyllid, the vector of greening disease. This shift to indoor container-grown systems has given rise to problems of bud failure and poor/slow scion growth especially during winter months. It was hypothesized that common trifoliolate orange rootstocks, because of their deciduous habit, are responsive to photoperiod and show slow growth under short days, but this response is lost when budded with non-trifoliolate scion varieties. This study was conducted with the objective of determining the effect of photoperiod on the growth of container grown trees of two trifoliolate rootstocks, Carrizo citrange and Swingle citrumelo.

Half the trees of each rootstock were budded with Hamlin sweet orange while the other half remained unbudded. Three weeks after budding, the trees were moved into three separate growth chambers set to: short days (SD - 10 hr photoperiod), long days (LD - 14 hr) and short days + night interrupt (SD-NI - 10 hr photoperiod + 1 hr night interrupt). All chambers were set to 28°C/21°C day/night temperature. Both the budded as well as non-budded trees showed reduced growth under SD conditions. However, the plants under SD-NI grew similar to those under LD. The average growth was 19 cm in SD, 52 cm in LD, and 55 cm in SD-NI, across all combinations. The difference in growth between budded and non-budded trees within SD was not significant while it was highly significant in LD and SD-NI. Over 12 weeks, the number of new leaves on non-budded trees increased significantly in LD and SD-NI, but not in SD. The average increase in leaf number was 13 in SD across all combinations, while it was 30 and 32 in LD and SD-NI, respectively. This shows that the trifoliolate leaves respond to day length. Although instantaneous photosynthetic rate was higher in SD and SD-NI than in LD, the estimates of total daily net assimilation were similar under all the photoperiods. It was concluded that the growth of trifoliolate rootstocks and non-trifoliolate sweet orange budded on trifoliolate rootstock is reduced under SD. The ability of a 1-hour night interrupt to overcome the SD response indicates that this is a phytochrome mediated photoperiod response and not a photosynthetic response.

*Specified Source(s) of Funding:* Florida Nursery, Growers and Landscape Association, Citrus Nursery Division

### **(243) String Blossom Thinner Designed for Variable Tree Forms Increases Crop Load Management Efficiency in Trials in Four Peach Growing Regions**

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Hand thinning is a necessary but costly management practice in peach (*Prunus persica*) production. Stone fruit producers are finding it increasingly difficult to find a workforce to manually thin fruit crops, and the cost of farm labor is increasing. Research conducted in 2008 and 2009 on string blossom thinner prototypes for vertical and open-center tree canopies, respectively, demonstrated that this new mechanical flower removal mechanism has potential to reduce labor requirement and improve fruit size and quality. A new "hybrid" string thinner prototype designed to adjust crop load in either vase or angled tree canopies was evaluated in processing and fresh fruit plantings in varying production systems in four growing regions in 2009. Data were uniformly collected across regions to determine blossom removal rate, fruit set, labor required for follow-up hand thinning, fruit size distribution at harvest, yield, and socio-economic impact. String thinner trials with the variable tree forms demonstrated reduced labor costs compared to hand thinned controls and increased crop value due to a larger distribution of fruit in higher market value sizes. Blossom removal ranged from 17 to 56%, hand thinning requirement was reduced by 19 to 100%, and fruit yield and size distribution improved in at least one string thinning treatment per experiment. Net economic impact at optimum tractor and spindle speeds was \$462 to \$1490 and \$230 to \$934 per acre for processing and fresh market peaches, respectively. Case study interviews of growers who thinned a total of 154 acres indicated that commercial adoption of string thinning technology would likely have positive socio-economic impacts.

*Specified Source(s) of Funding:* USDA, SCRI, Innovative Thinning of Fruit

### **(244) Timing of Dormant Applications of Vegetable Oil and Ethephon Affect Flower Bud Thinning**

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Flower thinning is often done to adjust crop load on early ripening or difficult to size peach cultivars to produce fruit with adequate size for the retail market. Pre-bloom flower bud thinning with vegetable oils such as soybean oil have been as effective as hand removal of flowers at bloom in increasing final fruit size. A combination application of soybean oil (e.g., Vegetoil®) and ethephon (i.e., Ethrel) to dormant peach trees have increased flower bud thinning, but results have been inconsistent possibly due to time of application. Peach [*Prunus persica* (L.) Batsch] cultivars of 'Cresthaven', and 'Rubyprince' near Clemson, South Carolina were sprayed at 5 different dates in both Winters 2008-2009 and 2009-2010 with Vegetoil® (VO), an emulsified soybean oil adjuvant (a.i. 93% soybean oil; Drexel Corp.) and Ethrel® (E) (a.i. 21.7% ethephon). The rates were 10% VO combined with 75 ppm ethephon. The control treatment each year was a December application of 3% petroleum-based dormant oil. In 2009, the VO plus E treatments significantly reduced flower bud survival and fruit set in both 'Rubyprince' and 'Cresthaven' on all treatment dates when compared to the control. The highest flower bud mortality for both cultivars occurred on the earliest (first) application date (treatment). 'Cresthaven' full bloom was delayed by the VO plus E treatment on 3 dates, but there was no effect on full bloom date for 'Rubyprince'. All treatments significantly reduced fruit yield (i.e., overthinned) for both cultivars. However, fruit size was not affected (i.e., not increased) with the thinning treatments. Fruit set and crop load was less than normal in 2009 due to poor pollination weather, so control trees did not have much excess crop to thin off and thus overall fruit size was large. Thinning and fruiting data for 2010 will be presented.

*Specified Source(s) of Funding:* South Carolina Peach Council

### **(245) Solvent Selection Influences Grapefruit Flavonoid Extraction**

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Citrus flavonoids and their association with prevention of chronic diseases have been well documented. Due to structural variations, flavonoids have unique chemical properties; eventually their quantities vary with different extraction procedures. Earlier, reports on grapefruit flavonoids showed several disparities. This is possible due limited information on optimization of extraction

procedures. In present study, factors affecting the extraction of flavonoids such as solvent selection, centrifugal speed and temperature were investigated. Flavonoids were quantified using a high performance liquid chromatographic method. Flavonoids were eluted by a binary mobile phase with 0.03% phosphoric acid and acetonitrile and separated in 20 min. Among the five solvents examined, dimethyl sulfoxide (DMSO) and dimethylformamide (DMF) have efficiently extracted five flavonoids such as narirutin, naringin, neohesperidin, didymin and poncirin. This may be due to higher polarity of DMSO and DMF compared to methanol (MeOH), ethanol (EtOH) and acetonitrile (ACN). Extracts of DMSO and DMF showed homogenous distribution of flavonoids, while MeOH, EtOH and ACN extracts showed significant variations in their distribution after centrifugation. Temperature and centrifugation speed did not have a significant increase in the flavonoid levels.

*Specified Source(s) of Funding:* The present research is funded by "Designing Foods for Health" through USDA CSREES Grant #009-34402-19831

### **(246) Ethylene Treatment Minimally Affects Star Ruby Grapefruit Bioactive Compounds and Their Radical Scavenging Activity**

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In recent years bioactive compounds have shown potential as anti-inflammatory, anticarcinogenic and cholesterol lowering agents. Citrus fruits contain bioactive compounds such as triterpenoids, flavonoids, phenolics, folic acid, furocoumarins and vitamins. Early season mature citrus fruits are commercially treated with ethylene to improve peel color and marketability. In the present study, investigations were conducted to understand the effect of ethylene on Star ruby bioactive compounds and their radical scavenging activity. Star ruby fruits were degreened in commercial packing shed and later stored under simulated market conditions for 5 weeks. Ethylene degreening enhanced the peel color of degreened fruits but had no remarkable effect on internal fruit color. Bioactive compounds from non-degreened and degreened fruits were quantified by HPLC. Nomilin content in degreened fruits was higher than non degreened fruits after 35 days of storage. No significant effect of ethylene treatment was observed on carotenoids and ascorbic acid content. Radical scavenging activity of Star ruby fractions were determined us-

ing 1,1-diphenyl-2-picryl hydrazyl (DPPH) method and results were expressed as ascorbic acid equivalents. Radical scavenging activity of degreened fruits was higher after 0, 7 and 14 days of storage as compared to non-degreened fruits. Total phenolics in the Star ruby fractions were determined by Folin-Ciocalteu method and results were expressed as catechin equivalents. No difference was observed in total phenolics content in both treatments and there was gradual increase up to 35 days. Therefore it may be possible to use degreening to improve fruit appearance and aesthetic value while minimally affecting bioactive compounds present in Star ruby grapefruit. To best of our knowledge this is first report on variation of bioactive compounds and their radical scavenging activity in edible portion of grapefruit after ethylene treatment.

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### **(247) Early Cropping of ‘Peach’ and ‘Willamette’ Chinese Chestnut Trees**

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Studies were conducted to characterize bur and nut development on shoots of young chestnut (*Castanea* sp.) trees over a two year period. Terminal shoots of ‘Peach’ trees with primary (1°) and 2° burs (PS) grew longer and had greater stem diameter than those shoots with 1° burs only (PO), 2° burs only (SO), or with no burs (VO) in 2005. PS shoots of ‘Peach’ had greater 1° nut weight per shoot than the other types of shoots in 2006. PS shoots also produced 2° nuts with as much or more weight per shoot than SO shoots. For ‘Peach’ trees, 2005 fruiting or vegetative shoots were most likely to develop a VO shoot in 2006. PS shoots of ‘Willamette’ trees typically produced more 1° nut weight per shoot than the other types of shoots. However, 2° nut weights per shoot were similar for PS and PO shoots on ‘Willamette’ trees. The odds of 2005 fruiting or vegetative ‘Willamette’ shoots developing into PO shoots the following year were  $\geq 50\%$ . Because many ‘Willamette’ shoots labeled in 2005 had the capacity to fruit the following year, these trees were precocious with marketable yield four years after grafting.

### **(248) Clonal Walnut Rootstocks in Northern California**

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The California walnut industry primarily utilizes two rootstocks for commercial production, Northern California Black (*Juglans hindsii*) or Paradox hybrid (*J. hindsii* × *Juglans regia*). Both rootstocks are open pollinated resulting in genetic variability. Due to superior vigor, better adaptability to marginal soils and greater tolerance to *Phytophthora* crown and root rot, Paradox is the preferred rootstock for northern California. Recent technology has resulted in micropagation and commercial availability of three new clonal Paradox walnut rootstocks, RX1, VX211 and Vlach. Clonal rootstocks have several horticultural advantages. First, they can be selected for desirable attributes such as disease resistance, nematode tolerance and vigor giving farmers the opportunity to match rootstock selection with planting sites. Second, they will impart less genetic variability and be more predictable in the orchard. Disadvantages include loss of genetic diversity in orchard plantings and additional expertise required to micropropagate, nursery culture and graft to produce a commercially viable product. Two rootstock experiments have been planted in northern California. The Tehama County plot is a randomized complete-block design with five rootstocks and five replicates. Rootstocks include VX211, Vlach, RX1, June budded Vlach and seedling Paradox as the control comparison. Rootstocks were micropropagated at Northern California Plant Lab and grown for one year in a commercial nursery. Ungrafted rootstocks were planted in Mar. 2009 into fumigated class one Columbia loam soil at a tree spacing of 14 ft × 26 ft. Trees were budded in Sept. 2009 to the Howard (*J.regia*) variety. Micro-sprinklers are used for irrigation. The Solano County plot is a randomized complete block design with five rootstocks and six replicates. Rootstocks were propagated by the UC Davis walnut breeding program and were grown for one year in a commercial nursery. Rootstocks include Vlach, RX1, VX211, Burbank and seedling Paradox as the control comparison. Rootstocks were planted March 2009 at a tree spacing of 18.5 ft × 24 ft and budded in August to the Tulare (*J. regia*) variety. In both experiments, Vlach and VX211 demonstrated very good tree

vigor. In the Tehama site seedling Paradox grew as well as the two clones while at the Solano site seedling Paradox was less vigorous. RX1 was the less vigorous in both sites when compared to VX211 and Valch. Burbank was the least vigorous rootstock in the Solano experiment.

*Specified Source(s) of Funding:* California Walnut Board

### **(249) Comparisons of Scion/Rootstock Circumference Ratios among Pistachio Cultivars and Rootstocks in California**

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Similar growth rates of scions and rootstocks are desirable for fruit and nut tree crops to provide a strong graft union. In pistachio, a scion/rootstock trunk ratio close to 1 provides a uniform surface for connection of the mechanical shaker to the tree trunk during nut harvest. Typically, several pistachio trees are shaken per minute and large differences in the circumference of scion and rootstock can result in bark damage and delays in the harvest process. Future possible graft incompatibility issues are also a concern as trees age although there is no evidence to suggest that incompatibility from overgrowth is an issue. Scion cultivars are *Pistacia vera*, and are grafted almost exclusively to *P. integerrima* or *P. atlantica* x *P. integerrima* hybrid rootstocks in the U.S. because of the resistance of *P. integerrima* to soil-borne Verticillium wilt and its ability to produce a rapidly growing, early fruiting tree. The female cultivar ‘Kerman’ and the male pollinizer, ‘Peters’ are the primary cultivars grown in California, and growth rates of scion and rootstocks appear to be similar. Newer alternative and improved *P. vera* cultivars have been reported to show varying amounts of scion overgrowth when grafted to existing commercial rootstocks with *P. integerrima* parentage. Newer scion cultivars are important to the industry for extending the harvest season, improved nut quality and pest avoidance. Differences in growth rate of scion and rootstock were measured for a number of *P. vera* cultivars on *P. integerrima* or *P. atlantica* x *P. integerrima* hybrid rootstocks of existing trees of different ages in multiple sites in the southern San Joaquin Valley of California. Differences were found in the ratio of scion circumference to rootstock circumference between standard industry cultivars (‘Kerman’ and ‘Peters’) and other cultivars. The relationship between the scion/rootstock ratio with time developed in this study would provide a baseline for measuring progress toward developing a rootstock with a growth rate more similar to those of newly developed or introduced cultivars.

Monday, August 2, 2010

Springs F & G

## **Plant Propagation**

### **(158) Effect of Gibberellic Acid and Substrates on Seed Germination and Growth Parameters of Christmas Palm (*Adonidia merrilli* Becc.)**

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Palms are important landscape ornamentals throughout the tropics, and are increasingly used as components of elaborate interiorscapes within malls and office buildings as well as exteriorscapes in home gardens and public gardens. Palms are usually propagated by seeds but germination of seeds for many species is often slow and erratic and germination percentage can be very low. Most of palm seeds germinate best if they were treated with Gibberellic acid and maintained in a good porous and nutritious substrate. This treatment also plays an important role in the vegetative growth of the seedlings.

*Specified Source(s) of Funding:* The Univ of the West Indies

### **(159) In Vitro Germination of Four Rare Endemic Hawaiian *Cyanea* spp. for the Restoration of Plants Extinct in the Wild**

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The Hawaiian Islands are noted for a high rate of endemism and endangered species. *Cyanea superba* ssp. *superba*, *C. grimesiana* ssp. *grimesiana*, *C. pinnatifida*, and *C. truncata* are four endemic species in the Campanulaceae family that are extinct in the wild. All are targets for in vitro propagation for genetic banking and restoration efforts. Four protocols were investigated for the in vitro establishment of these species from seed, obtained in the form of mature and immature fruit or seed. Intact fruits were sterilized by the dip and flame method—dipping intact fruit in 95% ethanol then applying to flame. Seeds were sterilized by chlorine gas formed by the addition of concentrated hydrochloric acid to 85% chlorine bleach, 10% chlorine bleach with Tween® 20, or a soak in 5 ppm Plant Preservative Mixture™ biocide/fungicide (PPM) in ½ Murashige and Skoog liquid media followed by the same chlorine bleach sterilization. Immature fruit of *C. superba* ssp. *superba* were sterilized using the dip and flame method, achieving 9% germination. Mature seed germinated at 63% under bleach sterilization, compared to 41%

under an application of PPM and bleach sterilization. Seeds from immature fruit of *C. grimesiana* ssp. *grimesiana* germinated at a rate of 35% using the dip and flame method, while mature seed germinated at 31% using bleach sterilization. The dip and flame method on immature fruit of *C. pinnatifida* yielded 37% germination. Mature seed germinated at 43% with bleach sterilization, and 47% with gas sterilization. Germination rates for *C. truncata* of 14% from immature fruit and 76% from mature fruit were achieved using the dip and flame method. Direct bleach sterilization of immature seed yielded 44% germination. Mature seed germinated at a rate of 97% with bleach sterilization, and 39% with the application of PPM followed by bleach sterilization. According to data from the Lyon Arboretum Seed Conservation Laboratory, under standard conditions, average germination percentages for mature seed are 34% for *C. superba* ssp. *superba*, 85% for *C. pinnatifida*, and 67% for *C. truncata*. Due to the rarity and value of these seeds, viability testing has not been done, and data for *C. grimesiana* ssp. *grimesiana* does not exist. All protocols proved effective in establishing these rare plants in vitro from seed.

### (160) Seed Treatments for Enhanced Germination of *Paspalum vaginatum* 'Seaspray' Seed

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Four temperatures, 20, 25, 30, and 35 °C were tested to determine the optimum temperature for seed germination of *Paspalum vaginatum* 'Seaspray' seed. Results indicated that *Paspalum vaginatum* germination percentage was greatest at 30 °C. Three seed enhancement treatments were applied to *Paspalum vaginatum* seed to determine improvements in germination percentage and MTG of the seed. Potassium nitrate, GA, and soaking seed in distilled water yielded greater germination percentages than the dry control. Seeds subjected to enhancement treatments had significantly faster MTG rates than the dry control seeds. Seeds also had higher germination percentage with exposure to light when compared to seeds that germinated in conditions not exposed to light. MTG was not significantly different.

*Specified Source(s) of Funding:* Louisiana State Univ

### (161) Regeneration of *Laurocerasus hypotricha* (Rehd.) T.T. Yu & L.T. Lu

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One of the key challenges to introduce new woody plants is their difficulty of regeneration. *Laurocerasus hypotricha* (Rehd.) T.T. Yu & L.T. Lu (hairy cherry laurel) is an evergreen tree with dense, lustrous foliage, loaded fragrant white flowers and smooth, reddish brown trunk. It has the great potential as an ornamental plant in various landscapes, especially urban conditions. To produce this plant commercially, seed germination, cutting propagation and tissue culture had been investigated. Seeds were collected and prepared for directly sowing and storing in room temperatures and moisture sand. All seeds were germinated under sand, loess and their mixes in outdoor conditions. Germination rates ranged from 50 to 67.4% and no significant difference was observed among the treatments. Cuttings had been collected in spring, summer and autumn, treated with 1000, 3000, and 8000 mg·L<sup>-1</sup> of IBA and NAA and rooted in media of perlite, sand, and mix of sand and loess. Timing had significantly effect on rooting of hairy cherry laurel and less than 10% of rooting rates were obtained from spring softwood and summer semi-hardwood cuttings. Hardwood cuttings collected in autumn had 75% of rooting percentage and better quality of root system. The rooting hormone of 1000 or 3000 mg·L<sup>-1</sup> KIBA and perlite media should be applied. Young stems containing one axillary bud were disinfested and established on MS media. The sprouted shoots were cultured on MS media supplemented with 6-benzylaminopurine (BA) at 0.5 or 1.0 mg·L<sup>-1</sup> and/or 1-naphthaleneacetic acid (NAA) at 0.01, 0.05 or 0.2 mg·L<sup>-1</sup>. BA and NAA did not significantly increase the number of shoots, but showed lower percentage of multiplication after 5 weeks with MS media supplemented with BA 1.0 mg·L<sup>-1</sup> and NAA 0.1 mg·L<sup>-1</sup>. To induce rooting, shoots were subcultured on MS or ½ strength MS medium containing either NAA at 1 mg·L<sup>-1</sup> or indole-3-acetic acid (IAA) at 0.1 or 0.5 mg·L<sup>-1</sup>. Roots produced after 3 weeks and the highest rooting rate of 33.0% was obtained under ½ MS supplemented with NAA 1.0 mg·L<sup>-1</sup>. Hairy cherry laurel could be regenerated from seeds, stem cuttings, and tissue culture. Further studies should focus on increasing its reproduction rate.



### (162) Propagation Medium Influences Success of *Comptonia peregrina* L. Rhizome Cuttings

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There is increased interest in using native plant alternatives to invasive species for landscaping. While some native plants are commonly used, others with ornamental potential have yet to be developed. *Comptonia peregrina* L. (Sweetfern) exhibits wide adaptability in natural settings making it a prime candidate for use as a native landscape plant alternative for difficult sites. Research to optimize *C. peregrina* propagation by rhizome cuttings was conducted. Dormant rhizomes were cut into 5 cm pieces and planted in four different propagation mediums (MetroMix 510 growing medium, perlite, sand, vermiculite; n=32) in 5 cm × 5 cm × 7.6 cm containers. Containers were maintained in a dark cooler at 5 °C for 90 days before being moved into a warm greenhouse with set points of 23 °C day and 16 °C night for forcing. Cuttings were irrigated as needed and provided soluble 20-10-20 fertilizer at 200 ppm every seven days. Cuttings grown in vermiculite had 100% survival, while cuttings in MetroMix 510, perlite and sand had 81%, 81% and 6% survival, respectively. Cuttings in vermiculite produced the greatest number of shoots per pot (4.2) and total shoot length per pot (14.8 cm), but were not statistically different from the MetroMix 510 cuttings. Young plants derived from rhizome cuttings were transplanted into quart containers using a 4:2:1 bark: peat: sand growing medium and topdressed with 17-6-10, 8-9 month formulation controlled release fertilizer. After 60 days, plants were transplanted by placing two quart-container plants into a two-gallon container using the same 4:2:1 growing medium. Sixty days of additional growth in two-gallon containers produced full, well-established plants going into dormancy. This study demonstrates that full-grown two-gallon containers of *C. peregrina* can be produced in a single growing season from rhizome cuttings.

### (163) Efficiencies in Alginate Encapsulation of Vegetative Explants

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The goal of this study was to improve a non-mechanized bulk encapsulation technique to standardize encapsulation procedures and reduce the labor time compared to encapsulating individual nodes. Four mm-long nodal segments from Stage II cultures of *Hibiscus moscheutos* L. 'Lord Baltimore' were encapsulated as groups of 5 segments in matrix masses gelled with 2.5 - 3.25% sodium alginate that were solidified with 60 - 90mM calcium chloride in various experiments. Encapsulated masses were

placed in sterile Petri dishes, sealed with parafilm, and placed in darkness at 5 °C for four weeks. They were then removed from refrigeration and placed on fresh Stage II medium and incubated at 25 °C under cool white fluorescent lamps for four weeks when data were taken. There was a significant interaction between the alginate viscosity and the calcium chloride concentration for subsequent shoot length. The most axillary shoots grew when the masses were encapsulated in 3% alginate and 60 mM CaCl<sub>2</sub>. The longest shoots grew from nodal segments encapsulated with 2.75% alginate that was solidified with 60 mM CaCl<sub>2</sub>. The most roots grew from masses of nodal segments encapsulated in 2.5% alginate solidified with 60 mM CaCl<sub>2</sub>.

### (164) Effects of Substrates, Wounding, and Hormone Concentrations on Vegetative Propagation of Baldcypress

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In previous studies, baldcypress [*Taxodium distichum* (L.) L.C. Richard] clones were selected for tolerance to high pH soils, drought and foliar or soil salt exposures, and/or ornamental characteristics. The objective of the current research was to determine the treatment combinations that yielded optimum root quantity (percentage) and quality (root number, length and mass) for selected clones. Cuttings were treated with one of four K-IBA (potassium salts of indole-3-butyric acid) concentrations (0, 5,000, 10,000, 15,000 mg·L<sup>-1</sup>), wounded or not wounded (1 cm long basal incision) and rooted in one of three substrates (100% perlite, 100% peat moss, or 50% perlite : 50% peat moss). Data indicated a trade-off between potential rooting quantity and root quality measures when considering the effects of substrate. While rooting percentages were significantly affected by substrates only at  $P \leq 0.10$  (53% in 100% perlite versus 36% in 100% peat moss), there were highly significant ( $P \leq 0.0001$ ) differences in rooted cutting potential among substrates, as measured by the percentage of cuttings with basal callus. Cuttings placed in 100% perlite callused at 85 %, while cuttings placed in 100% peat moss callused at about 53%. Conversely, the 100% peat moss treatment yielded cuttings with significantly greater root quality for all measures, except root number per cutting. Wounding cuttings proved to have deleterious effects on root quality measures. Total root length was about 30% greater for non-wounded cuttings than for wounded cuttings. Increasing K-IBA concentrations did not significantly affect rooting or callus

percentages, but did significantly affect root dry mass, total root length, and average root length per cutting. Total root length increased from 10.8 cm at 0 mg·L<sup>-1</sup> K-IBA to 16 cm at 15,000 mg·L<sup>-1</sup> K-IBA. Results suggest that high quality baldcypress cuttings should not be wounded, should be treated with 15,000 mg·L<sup>-1</sup> K-IBA, and grown in a substrate with intermediate water holding capacity to achieve an acceptable balance between rooting percentage and rooted cutting quality objectives.

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### **(165) Clonal Propagation of Guava on Nodal Explants of Mature Trees**

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A regeneration system using the MS medium with thidiazuron (TDZ) and naphthaleneacetic acid (NAA) was developed for guava (*Psidium guajava* L.) from mature tree cultivars. To determine the best means for proliferation we tested different disinfection methods and plant growth regulators on in vitro culture establishment. The most effective method involved treating explants in a 15% bleach solution for 20 mins then culturing them in the medium with 250mg/L PVP. This method maximized the percentage of breaking new buds (53.3%) with the minimum browning rate (18.3%) for the explants. In terms of levels of TDZ and NAA, the best regeneration for guava (80%) was observed on medium with 1mg/L BA, 1mg/L Kinetin and 0.1mg/L NAA, producing the highest mean number of shoots (2.4). Shoots were then rooted (65%) when dipped in 1mg/ml IBA for 1 min and rooted plantlets survived after acclimatization to the greenhouse.

### **(166) Effect of Basic Medium and Plant Growth Regulators on In Vitro Multiplication of *Phaius tancarvilleae* (Banks ex L'Heritier) Blume**

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Effect of basic medium and plant growth regulators on *in vitro* multiplication of *Phaius tancarvilleae* (Banks ex L' Heritier) Blume was studied. There were 3 experiments. First experiment:

effect of basic medium on protocorm like body (PLB) induction was investigated. Buds were cultured on 5 basic media which were Vacin and Went (1949), Thomale GD (1954), Murashige and Skoog (1962), Knudson C (1946) and White (1963). Each medium was added 0.1 mg/l NAA and 0.5 mg/l kinetin. Second experiment: The best liquid basic medium (from first experiment) containing a combination of 0, 0.002, 0.004, 0.006, 0.008 and 0.010 mg/l Triacantanol and 0, 0.1, 0.5 and 1.0 mg/l BA was studied. Third experiment: the medium supplemented with the same concentration of triacantanol and BA as second experiment except the medium of this experiment was solid. After 16 weeks of incubation, the maximum number of PLB (3.25), the highest percentage of explants produced PLB (75) and the biggest width of explants (1.29 cm.) were obtained from Vacin and Went medium. In second experiment, after 12 weeks of incubation, the maximum number of PLB (6.75), the highest percentage of explants produced PLB (91.67), the biggest width of explants (1.12 cm.) and the heaviest fresh weight of explants (0.45 g) achieved from Vacin and Went liquid medium containing 0.004 mg/l Triacantanol and 0.1 mg/l BA. In third experiment, after 8 weeks of incubation, the maximum number of shoot (7.38 shoot), the highest number of PLB (1.50), the biggest width of explants (1.90 cm.) the heaviest fresh weight of explants (1.8 g) and the maximum number of root (4.37) also obtained from Vacin and Went solid medium supplemented with 0.004 mg/l triacantanol and 0.1 mg/l BA.

*Specified Source(s) of Funding:* Faculty of Agricultural Technology King Mongkut's Institute of Technology Ladkrabang

### **(167) Effect of BA and NAA on In Vitro Multiplication of Butterwort (*Pinguicula gigantea*)**

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Effect of BA and NAA on in vitro multiplication of Butterwort (*Pinguicula gigantea*) was studied. Leaves were cultured on MS (Murashige and Skoog, 1962) medium supplemented with 0.2, 2.0, 10.0 and 20.0 mg/l BA and 0.1, 1.0, 5.0 and 10.0 mg/l NAA, 3% sucrose, 0.8% agar. The pH of medium was adjusted to 5.7. It was found that the maximum number of shoots (21.75 shoots) were obtained from medium with 2.0 mg/l BA and 0.1 mg/l NAA when cultured on media for 8 weeks. The heaviest weight of explants (0.57 g.) achieved from medium with 2.0 mg/l BA and 5.0 mg/l NAA. The MS medium with 0.2 mg/l BA and 5.0 mg/l NAA gave the average of longest shoots (0.83 cm.)

*Specified Source(s) of Funding:* Faculty of Agricultural Technology

**(168) Use of Light-emitting Diodes in Anthurium and Orchid Micropropagation**

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Light quality influences the growth and morphology of plant tissues and plant development. Light-emitting diodes (LEDs) offer precise control of spectral composition and light quality. A comparison of growth under LEDs and white fluorescent lamps was conducted by placing in vitro cultures of anthurium and orchid explants under red LEDs, blue LEDs, and white fluorescent lamps. The objective of this study was to determine the effects of red LEDs and blue LEDs on micropropagation of anthurium ('UH 2357') and orchid (*Dendrobium Uniwai Royale* 'UH 1081') explants. Anthurium explants were grown in a half-strength Murashige and Skoog medium, supplemented with 15% coconut water, 20 g/L sucrose, and solidified with 2.0 g/L gelrite. The pH was 5.7-5.8. For the orchid, we used a modified Vacin and Went medium plus 17.5 g/L banana powder, 15% coconut water, solidified with 6.5 g/L agar, at a pH 4.8-5.0. Containers with the explants were placed under red LEDs, blue LEDs, and cool white fluorescent lamps at a light level of 69-70  $\mu\text{moles}/\text{m}^2/\text{s}$ , 12-hr photoperiod, and 25-26°C. The red LEDs and blue LEDs had a higher percentage of alive shoots compared to the fluorescent lamps. The red LEDs resulted in greater shoot height than the other treatments. The fluorescent lamps had a higher callus dry weight than the blue LEDs, with the red LEDs not significantly different from the other treatments. There were no significant differences among the light treatments for the number of alive shoots, total number of shoots, shoot dry weight, root dry weight, and percent partitioning of dry weights for shoots, roots, and callus. With the blue LED treatment, the pigment saturation seemed higher, with darker green leaves and more red/maroon in the shoots. With the red LEDs, the shoots lacked pigmentation in the shoot and leaves. Also, average leaf size was smaller than with the other treatments. For 'UH 1081' orchid, there was no significant difference in total dry weight among the light treatments. In conclusion, LEDs offer a possible means of manipulating the growth of anthurium explants.

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Monday, August 2, 2010

Springs F &amp; G

**Produce Quality/Health Properties 1****(145) Quality Evaluation of Scented Green Tea Manufactured by the Fixing Time based on the Chemical Factors**

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In the quality estimate of the scented green tea per fixing time, the 12-hour fixing time obtained the highest score in the flavor and taste, followed by the 18, 6, 24 hours of the fixing time and the control group of the green tea. The appearance color and the color tone of interior quality were observed to be the best in the untreated green tea and they became deteriorated as the fixing time increased, showing the 24-hour fixing time had the lowest value of chromaticity, and the tea with that fixing time was shown to have the most severe degree of fading, that is, the green color was remarkably decreased and its browning process was actively expanded. The total score for all the teas was highest in the 12-hour fixing time as 85.3, followed by the 18 hours, 6 hours and 24 hours of the fixing times. Even the scented green teas with the fixing time having the lower score were also evaluated to be "good" and "slightly good" and in addition, the evaluation was better than that of the control group as evaluated to be "normal". And there were no great differences in the quality between those scented green teas.

**(146) Effects of Tea Water Absorption by Fixing Time on Chemical Quality Change of Scented Green Tea**

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The water content of the tea during fixing significantly increased with longer fixing time, and as the value of correlation coefficient indicated positive(+) correlation. The ingredients that maintain strong positive correlation with the water content that the tea absorbed during fixing are tannin, catechins,

fumaric acid of organic acid, chlorophyll a and b etc, and L, a and  $\Delta E$  among chromaticity, and those that maintain strong negative correlation with the water content that the tea absorbed during fixing are oxalic acid, malonic acid and citric acid, and b, b/a and etc., that indicate the browning of tea, so the water content of the tea during fixing at significance 0.05. Hydrophilic amino acids indicated relatively highly positive correlation of 0.77 or higher with the water content that the tea absorbed during fixing, so the water content that the tea absorbed during fixing affected more than fixing time, and hydrophobic aliphatic amino acids showed higher negative correlation with fixing time

### **(147) Effects of Fixing Time on the Flavoring Efficiency and Flavor Characteristics of Scented Green Tea**

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As the total flavors in the scented green tea per fixing time, 101, 102, 99, and 86 types of volatile flavors were detected by the order of 6, 12, 18, and 24 hours of the fixing time in scented tea manufacture by fixing times. The total content of volatile flavors and the scenting efficiency for the ratio of the increased volatile flavor after scenting In the scented green tea per fixing time, the volatile flavor of more than 1.2 ppm was detected as 34 types of the flavors in total. It was 12-hour fixing time which led to the most content of the aroma generated during manufacture and the gardenia floral aroma, followed by 18, 24, and 6 hours. That is, the 12-hour fixing time contained the most gardenia floral aromas and the aromas generated during manufacture, showing the excellent scenting, and allowed the representative flavor character of the scented green tea.

### **(148) Effects of Tea Moisture Absorption by the Fixing Time on the Sensual Flavor Characteristics of Scented Green Tea**

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Gardenia floral aroma was most detected in the scented green tea as scented per fixing time, followed by fresh and mild green leaf aroma, fruit aroma, delicate floral aroma, jasmine floral aroma, spicy and woody aroma, and sweet and light floral aroma. And those flavor characters made a strong positive correlation as more than 0.85 with the tea moisture absorbed during the fixing, so the larger the moisture absorption is during the fixing, the more increased those flavor characters became. In other words, the moisture in the tea during the fixing served as a factor to increase flavors. Off flavor was strongly affected by the fixing time; that is, 1-penten-3-ol and 1-penten-3-one, which are generated during the post-fermented process in the accumulated tea, were observed to be great as the fixing time became decreased, so the fermentation flavor was increased at the early stage, as a short fixing time, and 1-octen-3-ol which is a storage off-flavor and mold off-flavor was increased continually from 12 hours of the fixing time when the fixing time became increased although it was not detected in the shorter fixing time, 6 hours.

### **(149) Comparison of Antioxidant Content in Apple Cultivars using Methanol Extracts and Simulated Gastrointestinal Digest Extracts**

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There is a great interest in improving human health through improving functional quality of fruits and vegetables. An outcome of this trend is the push to include functional contents as selection criteria for breeding new cultivars. The evidence to justify this direction for breeding in apples is based on limited information, mostly comparing relatively old cultivars of apples and assuming that phenolic content of methanol extracts should represent the health potential of a particular cultivar. This work was undertaken to evaluate new and established dessert cultivars of apples for phenolic and antioxidant contents (i.e. peroxy radical scavenging capacity; PRSC). The evaluation was performed on methanol extracts as well as on *in vitro* simulated gastro-intestinal digest extracts. The results of the work show that only about 30% of the total phenolics measured in methanol extracts was soluble in the digest extracts. Clearly not all phenolics in an apple are bioaccessible. The newly released cultivar 'Nicola' had consistently the highest phenolics content. When evaluating PRSC, it was found that contents in the digest for a cultivar were either similar to or higher than in the methanol extract. Air storage duration and year had some effect

on overall PRSC but significant differences among cultivars were not found. Therefore antioxidant capacity in the apples was not clearly associated with total phenolic contents in the apple cultivars tested. These results suggest that while it may be possible to identify apples with higher phenolic contents this does not necessarily translate to increased antioxidant content (i.e. PRSC). It is likely that only a small subset of phenolics and other constituents, such as ascorbic acid, may be determinants of antioxidant content (PRSC) in apples.

*Specified Source(s) of Funding:* Agriculture and Agri-Food Canada

### **(150) Effect of Maturity Stage of Papaya 'Maradol' on Physiological and Biochemicals Parameters**

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Nowadays, the worldwide increase in diseases has motivated consumers to increase the intake of fruits and vegetables, in response to various research reports indicating that these produces can help to prevent and control certain types of illnesses, due to their potentially high antioxidant properties. In this work the effect of the stage of ripeness of papaya (*Carica papaya* L) on the content of bioactive components and antioxidant capacity was evaluated. Papaya was selected based on its visual ripeness, classifying it in four stages of ripeness (R1, R2, R3 and R4). Physiological and physical-chemical analysis performed included polygalacturonase (PG) and pectin methylesterase (PME) activity, total phenolic content, antioxidant capacity (measured using DPPH, TEAC and ORAC assays), firmness, pH, titratable acidity, total soluble solids, and color (L\*, a\*, b\*, °Hue, C). The antioxidant capacity decreased 27% in the R4 in DPPH and TEAC, while there was an increase in ORAC values (60.9%) respect to R1; PG activity increased as the stage of ripeness of papaya fruit increased from 8.14 (R1) to 22.48 U/gfw (R4). PME was affected in a similar manner with an activity of 0.5562 U/gfw, at the end of the storage. A high correlation between activity PG and softening of ripening papayas was observed. During this study it was observed that papaya experienced changes in firmness, which correlated with the activity of PG and PME enzymes, and with the increase in respiration and ethylene production. In regards to antioxidant capacity (measured using DPPH, ABTS and ORAC techniques) the various stages of ripeness showed very good antioxidant

capacity, being higher in R1, which correlated with the higher content of phenolic compounds found in this same ripening stage.

### **Monday, August 2, 2010 SCRI Project Directors Poster Session**

Springs F &amp; G

#### **(SCRI-01) Increasing the Sustainability of Sod Production using Biosolids**

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Land application of municipal biosolids can improve soil physical properties while providing turfgrass with essential nutrients. Biosolids may also mitigate the loss of soil from sod producing fields during sod harvest operations. The objective of this study is to increase the profitability and sustainability of sod production using biosolids-based systems at sod production farms in Wisconsin and Virginia. These production systems were designed to limit soil removed during harvest, reduce fertilizer and pesticide inputs, and provide an economical approach to biosolids reuse. Three replications of seven treatments were arranged in a randomized complete block design at a sod production farm in Marshall, WI on a Dodge silt loam soil and in Remington, Virginia on a Cordorus silt loam soil. The Wisconsin project utilized two materials from the Madison Metropolitan Sewage District (dewatered class B biosolids "cake" and biosolids mixed with sand and sawdust), and applied both at three rates based on their estimated supply of plant available nitrogen. The final treatment was a control which mimicked conventional sod maintenance techniques including synthetic nitrogen fertilizer. The Virginia project utilized two materials from the Alexandria Sanitation Authority (anaerobically-digested class A cake and this material blended with fine wood chips), and applied at three rates based on their estimated supply of plant available nitrogen. Biosolids were incorporated to a depth of 5 cm and plots were seeded to 'Midnight' Kentucky bluegrass (*Poa pratensis*) in Wisconsin, and 'Rebel IV' tall fescue (*Festuca arundinacea*) in Virginia. During establishment in 2009, turf quality, stand density, color, and soil volu-

metric moisture content were measured. Preliminary data from Wisconsin showed that applying biosolids cake at double the annual turf nitrogen demand ( $500 \text{ kg}\cdot\text{ha}^{-1}$  of N) resulted in significantly higher turf density and color compared to applying at the annual nitrogen rate. Furthermore, biosolids cake applied at  $\geq 500 \text{ kg}\cdot\text{ha}^{-1}$  of N had quality and color similar to or better than the conventional maintenance control throughout establishment. Preliminary data from Virginia showed that applying biosolids cake at 1.5 times the annual turf nitrogen demand ( $300 \text{ kg}\cdot\text{ha}^{-1}$  of N) resulted in significantly higher turf density and color compared to applying at the annual nitrogen rate. Furthermore, biosolids cake applied at  $300 \text{ kg}\cdot\text{ha}^{-1}$  of N had quality and color similar to or better than the conventional maintenance control throughout establishment. These preliminary results suggest biosolids-based sod production can meet agronomic goals. Economic and soil loss data during harvest analysis is ongoing.

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

### **(SCRI-02) Generating Genomic Tools for Blueberry Improvement— An Update of Our Progress**

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There is increased demand for and consumption of blueberries worldwide because of their many recognized health benefits. Great strides have been made in blueberry cultivar development since its domestication using traditional breeding approaches. However, genomic tools are lacking in blueberry, which could be used to hasten improvement. The overall aim of our Specialty Crop Research Initiative project, "Generating Genomic Tools for Blueberry Improvement," is to develop genomic tools for molecular breeding and assessing genetic diversity of blueberry. Our specific objectives are to develop genomic resources for blueberry, which include expressed sequence tag (EST)

libraries, EST-derived molecular markers, and genetic linkage maps in diploid and tetraploid blueberries. We plan to use these markers to identify quantitative trait loci associated with cold hardiness, chilling requirement, and fruit quality traits in highbush blueberry (*Vaccinium corymbosum*), and in studies of genetic diversity, gene flow, and evolutionary relationships between wild blueberry species. In 2009–10, transcriptome sequences were generated from highbush fruit at different stages of development, flower buds at different stages of cold acclimation, and leaves by "next generation" 454 sequencing. Over 500,000 sequences were assembled into about 15,000 contigs, which are currently being annotated. SSR and EST-PCR primer pairs designed from previously available ESTs were screened for polymorphism in parents of the mapping populations and are being added to each map. Plants from the tetraploid mapping population were propagated and established at various locations. Plants from the diploid mapping population were evaluated for cold hardiness over two years. In a study on gene flow and yield in wild lowbush blueberry (*Vaccinium angustifolium*), two high- and two low-producing clones from each of two cultivated fields in Maine were used as pollen recipients in hand crosses. Mixtures of pollen from each clone's neighborhood, as well as the other three neighborhoods in that field, were applied in crosses. Interestingly, the lowest producer's yield (fruit set times mean berry weight) was increased by 2–6 times when pollinated by any of the three 'foreign' pollen neighborhoods as compared to their own neighborhood. A preliminary phylogenetic tree of *Vaccinium* species in the section *Cyanococcus* was constructed based on length polymorphisms of EST-PCR markers. The availability of these genomic tools generated as part of this project will allow future advances such as the development of a blueberry microarray to study gene expression, use of marker-assisted breeding in highbush blueberry, and insight into yield differences among wild, lowbush blueberry genotypes.

### **(SCRI-03) Screening of Onion Plant Introduction Accessions for Iris Yellow Spot Disease Severity**

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In the Western U.S., Iris yellow spot virus is a devastating foliar onion disease that is reducing bulb size and yield. The disease

is spread by onion thrips that are difficult to control. Disease symptoms are exacerbated by hot, dry climatic conditions that also favor rapid thrips multiplication and reduced control efficacy. Currently, no onion cultivar is resistant or tolerant to Iris yellow spot (IYS) and/or thrips damage. Certain onion foliar characteristics have shown nonpreferential feeding activity by thrips and may be the first step in developing IYS-tolerant onion cultivars. In the hopes of finding IYS-tolerant onion germplasm, seventy-five onion plant introduction accessions from the U.S. germplasm collection were selected and evaluated for IYS disease severity because they possessed a low amount of leaf bloom (degree of wax deposition) in a previous evaluation. IYS-infected onion bulbs were placed on the borders of the disease evaluation field to ensure that the virus was present for evaluation. No thrips control means were used during the growing season. Ten plants per plot were rated individually at three separate times throughout the growing season for IYS severity on a scale of 0 to 4, where 0 = no symptoms, 1 = 1 to 2 small lesions per leaf, 2 = >2 medium-sized lesions per leaf, 3 = lesions coalescing on more than 25% of the leaf, and 4 = more than 50% leaf death. At 20 weeks post transplanting, PI 239633, PI 264320, PI 321385, PI 546100, PI 546115, PI 546188, and PI 546192 exhibited less severe IYS symptoms than other accessions. Four weeks later, IYS symptoms became more severe on plants of these accessions, however; plants of PI 546115 and PI 546192 exhibited less severe symptoms than most other accessions that had not matured by this time. Through the evaluation of these onion accessions for IYS disease severity, the potential exists to develop onion cultivars that have increased IYS tolerance.

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#### **(SCRI-04) Evaluation of Onion Plant Introduction Accessions for Leaf Characteristics**

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Onion leaf color, leaf waxiness (bloom), and leaf axil pattern (or degree of openness) has been associated onion thrips feeding preference. Plants, that possess a closed (tight) leaf axil pattern, blue to dark green leaf color, and waxy leaves, are preferred by onion thrips while plants, that possess an open leaf axil pattern, light green leaf color, and glossy (non waxy) leaves, are not. Onion thrips is a major onion insect pest, that causes drastic yield losses and is difficult to control. Cultivars, that possess leaf characteristics not preferred for feeding by onion thrips, would be beneficial for increased yield and reduced chemical control methods. Seventy-five onion plant introduction accessions from the U.S. germplasm collection were selected because they possessed a low amount of leaf bloom (degree of wax deposition) in a previous evaluation or they had been originally collected from a country that is thought to include the center of domestication for onion (i.e. Central Asia). Accessions were evaluated for leaf

color (on a scale of 1 to 4 where 1 = light green color and 4 = blue), leaf waxiness (on a scale of 1 to 4, where 1 = glossy and 4 = waxy), and leaf axil pattern (on a scale of 1 to 4, where 1 = very open and 4 = tight) when grown in Las Cruces, NM. Seventeen accessions were rated as having light to dark green leaf color, three were rated as having semi-glossy to glossy leaves, and one possessed an open leaf axil pattern. PI 239633 and PI 289689 possessed glossy foliage that was dark green in color. PI 258956, PI 546188, and PI 546192 possessed semi-glossy foliage that was dark green in color. This germplasm could be used to develop cultivars that have semi-glossy to glossy foliage that is lighter in color and possibly less attractive to thrips for feeding.

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#### **(SCRI-05) Variation in Onion Thrips Number Per Plant among Onion Plant Introduction Accessions**

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Onion thrips are a detrimental onion insect pest that reduces bulb size and yield and is difficult to control. They are attracted to onion leaves that are blue to bluish green in color and have a thick waxy coating. Some research suggests that onion thrips are less attracted to leaves that are light green in color and possess little or no wax on their surface. In the Western U.S., Iris yellow spot virus is a devastating foliar onion disease that is spread by onion thrips. Onion germplasm, that is less attractive to thrips feeding, would aid in the development of disease tolerant cultivars. Seventy-five onion plant introduction accessions from the U.S. germplasm collection were selected because they possessed a low amount of leaf bloom (degree of wax deposition) in a previous evaluation. Accessions were evaluated for the number of thrips per plant when thrips number was counted from ten plants per plot at four separate times throughout the growing season. No thrips control means were used during the growing season. In general, thrips number per plant increased from 12 to 14 weeks post transplanting while the number decreased afterwards up to 20 weeks. At this time, there were fewer thrips per plant than at 12 weeks post transplanting. At 14 weeks, PI 248753, PI 248754, PI 274780, and PI 288272 averaged less than three thrips per plant that less than most entries tested and less than the average number of thrips per plant for all entries, 21. These accessions produced dark green leaves that had a moderate amount of waxy coating. They may have potential use in developing onion cultivars that are less preferred by thrips and possibly more disease tolerant.

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### **(SCRI-06) Innovative Technologies for Thinning of Fruit**

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Hand thinning of tree fruit is a labor-intensive and tedious process. Reducing the labor requirement through mechanization helps reduce labor costs, decrease the need for short-term labor scheduling during the bloom season, and improve profitability. This project, primarily funded through the USDA Specialty Crop Research Initiative with support from several funding sources, is investigating methods to mechanize fruit thinning tasks. Peaches have been the target fruit during the first couple of years' work on this project. With grower and industry cooperation, the project has already clearly demonstrated that mechanized peach thinning is viable. One particular thinning unit (Darwin string thinner) is now available for commercial purchase and use. However, further refinements and developments are being investigated, including automated positioning of the string thinner, design changes in a prototype drum shaker, and design of a selective thinning unit.

*Specified Source(s) of Funding:* USDA SCRI

### **(SCRI-07) A Multidisciplinary Approach to Sustainability and Profitability of U.S. Blueberry Production using the Tree-like Species *Vaccinium Arboreum***

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Sustainability of the U.S. blueberry industry is constrained by high production costs in many locations, including extensive soil inputs and the need to hand harvest fresh-market berries. A critical need exists to reduce costs and increase efficiency of blueberry production, enabling growers to remain competitive and profitable. *V. arboreum*, a wild blueberry species, grows

well on non-amended soils, and has a tree-like growth habit. Incorporating these traits into highbush blueberry would alleviate soil constraints and facilitate mechanical harvesting. Our objective is to utilize desirable traits from *V. arboreum* in blueberry production, through use as a rootstock or by hybridization with *V. corymbosum* (highbush blueberry). Using *V. arboreum* to produce hybrids or grafted plants that yield high-quality berries that are better suited to mechanical harvest and less dependent on soil inputs than conventional blueberry cultivars/systems would decrease production costs and increase sustainability. Both hybrids and grafted plants will be evaluated for soil adaptation, mechanical harvest potential, and fruit quality/yield. Identification of new tetraploid F1 hybrids between *V. corymbosum* and *V. arboreum* tetraploid plants (produced using colchicine) is ongoing; to date we have screened more than 50 hybrids for pollen fertility and have backcrossed 20 of the most vigorous and fertile to highbush cultivars. From these backcrosses, we obtained 4000 seedlings, representing three different *V. arboreum* lineages and 10 different highbush cultivars of varying chill requirement. These will go into field evaluation trials in Feb. 2011 at Florida and Alabama sites. In conjunction with breeding efforts, differences in gene expression in roots of *V. arboreum* and *V. corymbosum* clones grown under different pH conditions will be evaluated, and a linkage map for QTL and candidate gene analysis will be developed from a backcross *V. corymbosum* × *V. arboreum* population. Differences in root physiology between the two species, and among the F1 and BC populations, will also be determined in response to pH and other rhizosphere conditions. For grafted combinations, we are currently growing *V. arboreum* seedlings for use as rootstocks for southern and northern highbush cultivars. Research and grower demonstration plantings of grafted vs. own-rooted highbush blueberry will occur in Florida, Alabama, Oregon, and California. Additional studies will be done in concert with the above to evaluate diverse populations of *V. arboreum* seedlings for use as highbush rootstocks and to develop methods to asexually propagate desirable rootstocks.

*Specified Source(s) of Funding:* USDA-NIFA-SCRI award no. 2009-51181-06021

### **(SCRI-08) Advancing Blueberry Production Efficiency by Enabling Mechanical Harvest, Improving Fruit Quality and Safety, and Managing Emerging Diseases**

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The exponential expansion of the southern blueberry industry during the past three decades has been a remarkable success story within the U.S. specialty crops sector. Nearly one-third of the cultivated blueberry acreage is located in the South, and within the next 5 years the region is projected to become the largest blueberry-producing area in the nation. Growth in acreage and production has been especially rapid for the early-maturing southern highbush blueberries, which ripen during a favorable market window and provide an important source of income for small and medium-sized farms and a lifeline for the surrounding rural communities. However, in the face of increasing domestic supply, rapidly strengthening international competition, increased pressure on producer prices, and looming shortages in labor, southern blueberry growers will have to elevate their overall production efficiency considerably to remain profitable. This Coordinated Agricultural Project, funded in the first round of the Specialty Crop Research Initiative (SCRI) grants competition in 2008, is enabling an unprecedented leap in efficiency through a comprehensive, multi-disciplinary effort integrating three major themes: 1) overcoming the genetic, horticultural, and engineering barriers that stand in the way of machine-harvesting highbush blueberries for the fresh market; 2) improving overall fruit quality and safety; and 3) addressing emerging diseases that threaten the viability of the industry. An economic re-evaluation of the production chain, together with comprehensive efforts in outreach and technology transfer, ensures that new knowledge and technologies is being transitioned to practice. Key results and deliverables from the first year of this project will be discussed, focusing on breeding and comprehensive cultivar evaluation (especially of novel genotypes having crispy-textured berries) for mechanical harvestability; evaluating horticultural practices such as trellising, modification of bush architecture, and application of abscission agents to reduce losses during mechanical harvest; understanding pre- and postharvest factors affecting quality and consumer acceptability of southern highbush blueberry fruit; elucidating epidemiology and management of rapidly expanding systemic diseases, particularly stem blight (caused primarily by *Neofusicoccum ribis* and *Lasiodiplodia theobromae*), bacterial leaf scorch (caused by *Xylella fastidiosa*), and necrotic ring blotch (caused by *Necrotic ring blotch-associated virus*); and determining factors that affect blueberry producer willingness to adopt new technologies (such as machine harvester investments). Our research and outreach activities are being coordinated and integrated with other funded projects related to southern blueberry production and markets, notably the 2009 SCRI blueberry eXtension project and the 2008 NRI small-midsized blueberry farm prosperity project.

*Specified Source(s) of Funding:* USDA Specialty Crop Research Initiative (SCRI)

## (SCRI-09) Advancing Onion Postharvest Handling Efficiency and Sustainability by Multimodal Quality Sensing, Disease Control, and Waste Stream Management

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Onion is the third-largest fresh vegetable crop in the U.S. As a critical link between the farm and the consumer, post-harvest handling plays a vital role in the onion industry. The current sorting and storage system is largely based on human inspection and unable to confront challenges like the growing demand for high-quality products from consumers and looming shortages in labor. For example, postharvest diseases, identified by stakeholders as the most serious threat to onion profitability, often cause 50% storage losses due to lack of detection tools and management strategies. As a result of diseases and disorders, discarded onions from the packinghouse or storage can lead to environmental pollution as well as increased disease pressure in the field. This Standard Research and Extension Project will enable an unprecedented leap in post-harvest handling efficiency and sustainability through a systems approach and trans-disciplinary research and extension effort integrating three major themes: (i) improve the efficiency of online sorting by integrating X-ray and hyperspectral imaging technologies through a sensor fusion approach; (ii) reduce storage losses by developing gas sensing and tracing technologies, as well as evaluating the efficacy of postharvest disease management strategies; and (iii) manage the onion waste stream by developing a high-rate anaerobic digestion

system to convert discarded onions into energy. A socio-economic analysis to assess the potential for technology adoption along with comprehensive outreach efforts ensures that new technologies will truly benefit stakeholders. This project addresses three focus areas of the SCRI and priorities established in stakeholder surveys.

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

**(SCRI-10) Antimicrobial Incorporated Multi-angle Light Scattering Spectroscopy (ANIMALS) Facilitates Detection of *Escherichia coli* O157:H7 in Large Volumes of Irrigation Water**

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Contaminated irrigation water has been shown to be an important vehicle for transfer of *Escherichia coli* O157:H7 to produce. Timely detection of this pathogen in irrigation water can prevent contamination of the final product, and such detection should integrate concentration of pathogens from large volumes of water. Antimicrobial Incorporated Multi-angle light scattering spectroscopy (ANIMALS) is a recently developed method for rapid detection of foodborne pathogens. The objective of this study was to use the ANIMALS method to rapidly detect *E. coli* O157:H7 in large volumes of irrigation water. River water and reservoir samples were artificially contaminated with a 3 strain cocktail of *E. coli* O157:H7 at four concentrations including 100 to 103 CFU/ml). Following concentration by Modified Moore swab and continuous centrifugation, up to 50 ml of the

concentrates were further concentrated by immunomagnetic separation (IMS) and incubation in the presence (test samples) or absence (control samples) of a 37 strain bacteriophage cocktail (specific for *E. coli* O157:H7) in 10 ml of tryptic soy broth + 20 µg/ml novobiocin at 42° C. ANIMALS measurements were taken in a SpectraPoint light scattering machine (SpectraDigital) at 4, 6, 8 and 10 hours. Light scattering spectra of samples incubated with the bacteriophage cocktail differed markedly from non-bacteriophage treated samples that were used to obtain reference (control) spectra. An algorithm was developed to evaluate the area under the curve of all spectra. The means and standard deviations of the ratios of the differences between the test and reference spectra for the four concentrations (100 to 103 CFU/ml) of *E. coli* O157:H7 were analyzed as well as for negative controls (samples of river or reservoir water that were not inoculated with *E. coli* O157:H7). *E. coli* O157:H7 was consistently detected at concentrations from 101 to 103 CFU/ml in spiked river water within 8 hours (P<0.05). All concentrations (100 to 103 CFU/ml) were detected after 10 hours of enrichment (P<0.05). These results demonstrate the ability of ANIMALS to rapidly and sensitively detect the presence of *E. coli* O157:H7 in water used for irrigation of produce, even against a high number of background microflora.

**(SCRI-11) Concentration of Large Volumes of Irrigation Water Facilitates Sensitive Detection of Foodborne Pathogens II**

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Fecally contaminated irrigation water is frequently implicated as either a source of contamination of fresh produce with foodborne pathogens. Since the concentrations of pathogenic microorganisms in irrigation water are usually low, sampling of larger volumes of water should be performed prior to detection

and quantification. The objective of this study was to evaluate the use of Modified Moore swabs and continuous centrifugation to concentrate *Escherichia coli* O157:H7 and *Salmonella* spp. from large volumes of irrigation water. Three strains each of produce isolates of *E. coli* O157:H7 and *Salmonella* spp. were independently transformed with plasmids expressing one of red, green, or cyan fluorescent proteins. The strains were grown overnight and combined in two cocktails (one for *E. coli* and another for *Salmonella*), and suspended in 10 liters of water at final concentrations of 10-1, 100, 101, and 102 CFU/ml. Concentration via centrifugation was performed in a CFC-200 continuous flow centrifuge (Scientific Methods Inc., Granger, IN) at a flow rate of 300 rpm and 2500 × g. For Modified Moore swab filtration, concentration was performed at a flow rate of 300 rpm, using a peristaltic pump attached to a filter housing in which the swabs were placed. Following concentration, samples were surface plated onto tryptic soy agar supplemented with 50 µg/ml of ampicillin, followed by incubation at 37 °C for 24h. For samples with lower contamination levels (10-1 and 100/ml), 500 µl of concentrate was transferred to 5 ml of tryptic soy broth with ampicillin and enriched overnight at 37 °C with shaking, followed by testing via lateral flow assay (Neogen Corp., Lansing, MI). The results indicated that both *E. coli* O157:H7 and *Salmonella* spp. were concentrated by 1.5 to 2 orders of magnitude within 35 minutes, when either the Modified Moore swab, or continuous centrifugation was performed. Centrifugation was more sensitive than the Modified Moore swab, although this difference was statistically insignificant. At lower bacterial concentrations, the samples were enriched both pre and post-concentration, since the numbers of bacteria were below the levels of detection by plating. The results showed that *E. coli* O157:H7 and *Salmonella* were not detected in the 10-1 and 100 CFU/ml before concentration by either method, but were detected following concentration in the initial 100 CFU/ml sample (Moore swab) and 10-1 and 100 CFU/ml samples (centrifugation). Both Modified Moore Swabs and continuous centrifugation represent rapid methods to concentrate bacterial pathogens in irrigation water prior to detection.

### **(SCRI-12) Development of Two Intelligent Spray Systems for Ornamental Nursery and Fruit Tree Crops**

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Current application technology for floral, nursery, and other specialty crop production wastes significant amounts of pesticides. Two different real-time variable-rate sprayer prototypes for ornamental nursery and tree crops were developed to deliver chemicals on target areas as needed. The first prototype was a hydraulic vertical boom spraying system that used ultrasonic sensors to detect tree size and volume, and the second prototype was an air-assisted spraying system that used a laser scanning sensor to measure the entire tree structure. The automatic controllers developed for the prototypes consisted of a computer program, a signal generation and amplification unit, and pulse width modulated solenoid valves. The controllers analyzed sensor signals and actuated the solenoid valves to automatically provide variable flows to nozzles based on tree characteristics and plant occurrence. Preliminary laboratory and field tests demonstrated that both prototypes had the capability to control spray outputs that continuously matched canopy characteristics in real time.

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### **(SCRI-13) SCRI-MINDS: Some Management and Communication Strategies for a National Coordinated Agricultural Project (SCRI)**

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You receive the big grant, the accolades – and then reality hits. You have a big complex project with partners across the nation to get up and running—fast. Contracts need to be negotiated and signed, people hired and suddenly the Gantt chart at the back of the proposal seems so inadequate. Quarterlies are due, matching reports are required. What is one to do? Thankfully, your project has plan of governance and the institutional leads have thought through some of the key project management issues before submitting the grant, since now you really *are* now reliant on each other. If one cog isn't moving, this machine isn't going anywhere. This poster outlines the key components of our SCRI project management strategy and the tools we are using to ensure constant communication between our research, outreach and socio-economic teams, our advisory members and our grower partners. Most importantly, we outline how we are communicating our progress on a continuous basis to our industry and the public at large.

### **(SCRI-14) Increasing Consumption of Specialty Crops by Enhancing Their Quality and Safety (SCRI)**

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Despite widely advertised health benefits, most Americans do not eat their recommended daily servings of fruits and vegetables. We believe that inconsistent produce quality, particularly flavor, is a key factor contributing to this low consumption. Poor tasting produce is often associated with varieties that lack good flavor potential, immature products, and/or products that have been transported and stored in less than optimal conditions. This Coordinated Agricultural Project aims to help producers remove postharvest impediments that are keeping consistently great tasting produce from being marketed. Our goal is to show how fresh fruits and vegetables with enhanced flavor can be successfully handled, without compromising food safety, so as to improve consumer satisfaction and thereby change their buying habits to increase consumption. With a view toward increasing consumption of fresh fruits and vegetables, we are developing harvest and postharvest handling strategies that improve flavor

quality and safety for consumers. Our project brings together scientists from the Univ of California, Univ of Florida, and the USDA in partnership with leading growers, shippers, and retailers of berries, melons, pears, stone fruits, and tomatoes. Initially, we are identifying the critical flavor descriptors for each of these products and determining how produce flavor, as affected by harvest and postharvest practices, influences consumer purchasing decisions. We are also developing and evaluating rapid methods to monitor harvest maturity and critical eating quality characteristics identified by consumers. We will then develop and test improved supply chain capabilities to deliver produce with enhanced eating quality. Potential food safety risks associated with handling more mature or riper produce will also be determined. Our findings will be integrated into commercial operations and used to educate all participants in the postharvest value chain, including consumers, about optimal produce maturity, ripeness, quality and handling practices. We will regularly review project impacts on handling practices and purchasing behavior and determine the return on investment of new technologies and practices in terms of increased produce sales prior to recommending them to industry. We believe our research will provide the produce industry with practical strategies for consistently supplying riper, more flavorful fruits and vegetables to consumers.

### **(SCRI-15) Tree Fruit GDR: Translating Genomics Into Advances in Horticulture**

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The development of tree fruit Genome Database Resources (tfGDR, [www.tfgdr.org](http://www.tfgdr.org)) expands the Genome Database for Rosaceae (GDR, [www.rosaceae.org](http://www.rosaceae.org)) to include *Citrus* and other tree fruit species. Using a Chado database and Drupal interface, this comprehensive genomics, genetics, breeding and producer database platform will be extendable to other specialty crops. TfGDR currently provides access to the publicly available mapping, transcriptome and genome data for Rosaceae and transcriptome data for *Citrus*. User-friendly interfaces provide access to data-mining tools for basic, translational and applied researchers; publications, mailing lists and community communication forums.

### **(SCRI-16) (SCRI) Advanced Sensing and Management Technologies to Optimize Resource Use in Crops. II**

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Currently, the application of fertilizer and water in orchard crops follows largely standardized practices with limited consideration of temporal, climatic and crop variability. This approach constrains our ability to improve management, results in loss of potential income and causes negative environmental impact. In this project we strive to address this issue by integrating 1) new approaches to determine crop demand with spatial and temporal accuracy, with 2) advanced methods of estimating current crop status and performance with 3) the development a new site specific orchard management platform. In this poster (#2 of 2), we discuss integrated approaches to define real time crop 'status' for water and nutrients with high spatial and temporal specificity in deciduous perennial crops. In a partner poster we present advanced methods for crop 'demand' determination. A series of 8 research sites were established in 2008 throughout California, New Mexico and Texas in Almond, Pistachio and Pecan. Multiple in-season determinations of crop water and nutrient (all essential elements) have been conducted across all sites using a variety of methods and at several spatial scales from individual tree analysis (>1,500 individual data points at each sampling), to within canopy, above canopy and remote (aerial and Satellite) imagery. Analyses that have been conducted include: tissue nutrients (tissue sampling and elemental analysis; leaf-canopy-remote spectral analysis); plant water (plant stem water; modeled plant water status/demand (Eddy CoVar modeling, Sebal modeling, Warf Modeling); soil water (neutron probe, soil conductivity and capacitance, direct sampling). Preliminary results will be presented on the following: Nutrient and water variability within and between orchards and time Comparative efficacy of nutrient analyses by multiple methodologies (leaf analysis, SPAD, Ping Meter, NIR, hyperspectral analysis) Comparative efficacy and cross validation of water determination in plant and soils by multiple methodologies (stem water potential, spectral analysis, modeled demand) Impact of fertilizer rate trials and irrigation methodologies on crop response

## **(SCRI-17) Building Capacity for Florida's Small Farm Specialty Crop Industry with a Statewide Conference (SCRI)**

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Consumer interest and demand for local foods has changed the dynamic of the Florida small farms industry from a little-known group of clientele to a larger and more diverse clientele group that actively participates in Univ of Florida (UF) extension programming, on-farm research, local and state policy discussions, and partnership building. Based on the USDA definition, well over 90% of the over 47,000 farms in Florida are small farms. Florida reported an 8% increase in farm numbers from 2002 to 2007, essentially all in the small farm category. According to the 2007 US Ag Census, 89% of the Florida farms report less than \$100,000 in product sales. The other common characteristic of these operations is they are family-oriented farms dependent upon the family for management and labor. Extension programs can make a difference by providing educational information to help small farmers successfully start their farming operations or adopt new alternative enterprises. Current barriers include: access to markets, regulations, labor, locating materials, and supplies, size-appropriate production, technologies, and adoption of sustainable practices. The UF-IFAS Small Farms and Alternative Enterprises Focus Team consists of over 80 state and county faculty that self-affiliate with the extension programming of this team. Based on results of a statewide small farm survey, written evaluations from clientele attending county and regional programs, and informal discussions with stakeholders, industry partners and community organizations, a Stakeholder Planning Committee of 30 volunteer members was assembled in 2007 to plan the first statewide conference for small farmers. The two-year planning period and support from IFAS's Office of Conferences and Institutes was essential to our success. The result was a two-day event that included a large trade show with over 80 exhibitors, a live animal educational demonstration area, a keynote address, innovative farmer awards, six concurrent sessions including tracts in horticulture, alternative energy, alternative enterprises, policy & regulations, organic & sustainable farming, livestock, and business & marketing. Food featuring products from Florida small farms comprised refreshment breaks and lunches. The majority of the 800 attendees responded in a post-event evaluation that the networking was as equally valuable as the educational content. A second statewide conference will

be held in July 2010. Although strong partnerships have been developed with community-based organizations, institutional partnerships with Universities, FDACS, Farm Bureau, Farm Credit, and various USDA agencies will need to be strengthened to better serve the needs of small farmers.

### **(SCRI-18) Detection and Management of *Phytophthora* and *Pythium* in Carrot, Tomato, Cucurbits, and Asparagus (SCRI)**

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To better understand and manage vegetable diseases caused by *Phytophthora* and *Pythium* spp., studies were conducted to: **1)** Develop a nested-PCR method to detect *Pythium* spp. responsible for carrot cavity spot, and qPCR method for *Phytophthora capsici* quantification from soil; **2)** Examine the relationship between cucumber fruit development and resistance to *P. capsici*; **3)** screen pepper and tomato germplasm for resistance to *P. capsici*; **4)** Evaluate various fungicide chemistries for activity on *P. capsici*; **5)** Develop disease suppressive soil for managing carrot cavity spot; and **6)** Tested effects of cover crops on *P. capsici* population in cucumber and summer squash production. Methods and results are as follow. Resistant cucumber fruit [16 days post pollination (dpp)] did not prevent zoospore germination, but had fewer appressoria and more aberrant germ tubes of *P. capsici*. Pyrosequencing analysis of RNA from 0, 4, 8, 12, and 16 dpp fruit showed patterns of gene expression consistent with a profile of genes initially associated with cell division and rapid growth, followed by genes associated with defense. Germplasm screening showed pepper lines CM334, NY07-8007, NY07-8006, NY07-8006 were resistant to *P. capsici*. None of the commercial cultivars were resistant to isolate 12889. Tomato *Solanum habrochaites* accession LA407 was highly tolerant, and varieties Ha7998, Fla7600, Jolly Elf, and Talladega were moderately tolerant. When Zucchini 'Justice III' was grown in a *P. capsici*-infested field. Ridomil Gold MZ, Gavel, Kocide + Acrobat or Presidio or Revus or Ranman, all resulted in fewer dead or wilted plants than the untreated control. Cell packs were filled with *Pythium ultimum*-infested media and drenched with fungicides prior to sowing carrot 'Napoli'. All chemicals except Ranman resulted in more emerged seedling compared to the untreated inoculated packs. Conventional, transitional, and

organic farming systems were established. Soil samples from the plots were collected monthly, spiked with *P. ultimum*, and planted with cucumber seeds. The detrimental effects of *Pythium* spp. were reduced, but the beneficial effect of the elevated soil organic matter was fleeting. Both microbial activity and soil organic matter were positively correlated with disease suppression. In a commercial field infested with *P. capsici* oilseed radish (*Raphanus sativus*), oriental mustard (*Brassica juncea*), brown mustard (*B. juncea*), cereal rye (*Secale cereale*), and metam sodium affected soil microbial populations. However, the brassica cover crops did not impact disease incidence. Therefore, the cover crops can be used to improve crop rotation when *P. capsici* control is not the primary goal.

### **(SCRI-19) Advanced Sensing and Management Technologies to Optimize Resource Use in Crops. I (SCRI)**

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Currently, the application of fertilizer and water in orchard crops follows largely standardized practices with limited consideration of temporal, climatic and crop variability. This approach constrains our ability to improve management, results in loss of potential income and causes negative environmental impact. We strive to address this issue by integrating 1) new approaches to determine crop demand with spatial and temporal accuracy, with 2) advanced methods of estimating current crop status and performance with 3) the development a new site specific orchard management platform. In this poster (#1 of 2), we discuss integrated approaches to define real time crop 'demand' for water and nutrients with high spatial and temporal demand for water and nitrogen by deciduous perennial crops. In a partner poster we present advanced methods for crop 'status' determination. A series of 8 research sites were established in 2008 throughout California, New Mexico and Texas in Almond, Pistachio and Pecan. Fertilizer rate trials and nutrient monitoring (all essential elements) in plant, soil, and crop are being used to construct nutrient budgets with a high degree of spatial and temporal specificity. Water demand is being estimated with a number of redundant models and with real time monitoring of plant, soil and atmospheric parameters. Yield prediction and nutrient and water demand models are under development through the integration of multi-year yield monitoring in a large number (>1,500) individual trees. Fertilizer rate trials and irrigation treatments have been established to develop response curves and interaction required for model refinement. Preliminary results will be presented on the following: Whole tree nutrient budgeting Temporal pattern of nutrient uptake annually Within tree nutrient partitioning Yield estimation modeling Comparative analysis of soil, plant and model based determination of water demand

### **(SCRI-20) AgTools for Managing Financial Risk in Agriculture (SCRI)**

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Agricultural producers often make large up-front investments in producing and establishing cropping systems, purchasing equipment, buildings or new technologies in hopes of making a reasonable return on their investment. Misjudging the costs and potential returns of such investments can result in serious

financial difficulty. However, adequate compensation can come to those who have the information, develop strategies, and perform sensitivity analyzes before implementing a decision. The *AgTools™ for Managing Financial Risk in Agriculture* website hosts a suite of software programs with the aim to help agricultural crop producers make better decisions to manage the financial risk in agriculture. Currently five programs are available to U.S. agribusinesses – AgProfit™, AgLease™, AgFinance™, AgPlan™, and Tree Loss Calculator. Agriculture's Profitability Tool (AgProfit™) is designed to assist producers make long-run decisions by estimating machinery, building, labor, and production input costs and total yield for calculating returns for crops with multiple establishment and production years. The program can inflate return and input cost items over time to analyze the net present value, internal rate of return, and financial feasibility. Agriculture's Crop Lease Tool (AgLease™) is designed to assist growers and landowners establish equitable crop share and cash rent lease agreements. With AgLease™ you can easily comprehend and evaluate the potential risks associated with annual and long-term leases; reevaluate current leases, or changing cropping systems. The program allows you to inflate specific return and input cost items over time to analyze the net present value, internal rate of return, and financial feasibility for a crop share and cash rent lease. Agriculture's Financial Tool (AgFinance™) is designed to assist agricultural producers make long-run decisions on a whole farm basis. You can load scenario files from AgProfit™ and AgLease™ to analyze your farm's financial ratios and performance measures, which include working capital, current, debt-to-asset, and debt-to-equity ratios, earned net worth and net worth. AgPlan™ helps rural business owners develop a business plan. It is designed to provide customized assistance to different types of businesses. Tree Loss Calculator are spreadsheets designed to calculate the economic value of a pear, apple or cherry tree lost to external factors, such as hit by a vehicle. The value of this loss is dependent upon the value of the fruit, productivity of the lost tree, and years for which a new tree to produce the same amount of fruit as the lost tree.

### **(SCRI-21) Deployment of Nutrient-rich Nematode Resistant Carrots to Benefit Growers, Consumers, and the Environment (SCRI)**

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Carrots are an important source of nutrients for the U.S. diet and have \$550 million farm gate value to U.S. growers, but root-knot nematodes (*Meloidogyne* spp.) threaten about 3/4 of U.S. carrot crop. Nematode infection causes forking and galling disfigurement to carrot taproots resulting in 'cosmetic injury' and economic loss. New sources of genetic resistance to the two most important root-knot species affecting carrot production, *M. javanica* and *M. incognita*, have been identified in several unrelated germplasm sources from local carrot populations of diverse geographic origins including Brazil, Europe, Syria,



China, and Australia. Inbred lines, single cross hybrids, and diverse populations from several sources of resistance have been developed and evaluated on a small scale in field test sites heavily infested with nematodes. These sources of nematode resistance vary widely in nutritional value attributable to both carotenoid and anthocyanin pigments, and also vary in flavor. This project is moving nematode resistant carrots into mainstream production and also improving nutritional value of typical orange, nematode resistant carrots. The inheritance and genetic map location of resistance genes is being determined, and molecular markers are being developed to facilitate incorporation of resistance genes by indirect selection. Plants with superior levels of resistance have been selected and seed supplies of selected individual plants with elite high resistance were increased in collaboration with industry cooperators to provide adequate seed for larger scale testing in the upcoming year. Carrot types with unusual purple and yellow colored taproots that occur in resistant germplasm will also be available for large-scale and niche market growers. Seed companies and both large- and small-scale growers are involved in testing these improved carrot populations and hybrids. A web site is being developed to target large and small-scale carrot growers, and regular interactions with crop production and seed production industry personnel provide stakeholder input as a part of this project.

**(SCRI-22) Biodegradable Mulches for Specialty Crops Produced under Protective Covers (SCRI)**

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This SCRI SREP (No. 2009-02484) awarded on 1 Oct 2009 to a team of agricultural, materials, social and textile scientists, is ascertaining whether one experimental spun-bond nonwoven biodegradable mulch (BDM) and two leading commercially-available BDM products (BioBag, BioTelo) are of similar quality to conventional black plastic mulch for high tunnel and open field specialty crop production. A multi-site field experiment in the coastal climate of western WA, high plains of central TX, and subtropical region of TN is underway, with cellulose and non-mulch treatments as reference controls and tomato as the test crop. Three experiments on adaptability of six cultivars each of lettuce, strawberry and tomato to high tunnel production in these contrasting environments have also been initiated. In TN and TX field plantings have been established and in WA plants are ready for transplanting. Field and laboratory protocols for monitoring crop and soil interactions with the BDMs as well as assessing BDM properties, performance and degradation have been refined by team and advisory committee members. Also coordinated or under review for synchronous approaches are field plot designs; cultural practices; crop and harvest assessments; environmental monitoring; soil sampling and analysis; BDM sample receipt, storage and analysis; crop budgets; and, a framework for defining clean technologies. Input from growers in the three regions will be critical to successful adaptation, implementation and long-term feasibility of BDMs. Thus, procedures and criteria for recruitment and selection of potential focus group participants and survey respondents are being developed to understand values, beliefs and attitudes towards BDMs, and

the social norms and practices of participating communities. To date, an experimental BDM manufactured in Saxon, Germany for the project and the other four mulch products have been received at all three sites. One post-doctoral associate and four graduate students have been hired. Analytical equipment for the textile laboratory in WA and environmental monitoring instruments and field supplies for WA, TX and TN have been purchased. Baseline soil samples from TN have been analyzed for bulk density, microbial biomass C, two enzyme potentials related to C and N cycling, and microbial community structure via phospholipid fatty acid profiling (PLFA); baseline data from TX and WA soil samples is commencing. One internal website has been created for information sharing among team members, and one public website (<http://vegetables.wsu.edu/plasticulture.html>) has been dedicated for general outreach. This SCRI team and its advisory committee will meet June 24-25, 2010 in Mount Vernon, WA.

### **(SCRI-23) Locally Grown Ethnic Greens and Herbs: Demand Assessments and Production Opportunities for East Coast Farmers (SCRI)**

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This study primarily focuses on estimating consumer demand for ethnic greens and herbs, willingness to pay a premium for fresh leafy greens and herbs, document preferences for local produce and demographic characteristics of ethnic consumers'. The first phase of the project documents the consumer buying patterns relating to ethnic greens and herbs using Internet Bulletin Board focus group meetings. Four separate Internet bulletin board sessions were conducted to better understand consumer use of ethnic greens and herbs and perceived quality, price, and availability. Each of the two-day sessions, conducted from March 10 to 12, 2010, included eight to 12 consumer panelists who identified themselves with one of four ethnic groups: Asian Indian, Chinese, Mexican, or Puerto Rican. Panelists participated if they met the screener criteria: belonged to one of the ethnic groups of interest, primary grocery shopper, living within the East Coast region of the U.S., and at least 18 years of age. The Internet bulletin board methodology was chosen to allow panelists to respond to a variety of questions, posed by researchers, and respond to other panelists' submissions. Groups were segmented based on ethnicity in order to ascertain any issues related to specific cultures' use of ethnic greens and herbs and whether authentic products were available. Overall, availability of ethnic greens and herbs depended on panelists' location. As might be expected, panelists who mentioned residing in more metropolitan areas expressed that they had access to ethnic greens and herbs, and through at least one outlet. Others replied that certain greens and herbs were difficult to find locally. A minority of panelist reported traveling distances up to 40 miles from their residence to purchase such ingredients. Availability of ethnic markets, product quality and freshness, and price influenced their purchasing decisions. For those who were able to compare conventional grocery stores with ethnic markets, they noted that greens and herbs tended to be higher quality and, since they believed stock rotated more frequently at ethnic markets, were fresher and priced lower. While a few panelists provided prices for items sold at ethnic markets, compared to conventional grocery stores, most of the panelist either believed prices were lower. These responses will be used to construct a telephone survey of ethnic consumers matching the criteria stated above. Data from both studies will provide growers and retailers with information vital for meeting demand and exceeding the needs of ethnic consumers they serve.

Tuesday, August 3, 2010

Springs F &amp; G

## Crop Physiology: Cross-Commodity 1

### (075) An Essay of Super Sweet Corn (*Zea mays* L.) F<sub>1</sub> Hybrids Grown in La Costa De Hermosillo, Mexico

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A super sweet corn hybrids experiment was carried out utilizing a completely randomized design in La Costa de Hermosillo, Mexico 14 km west far away Hermosillo city during 2007 autumn season. Eight super sweet corn F<sub>1</sub> hybrids were tested on a grower commercial field. The plots were established under a drip irrigation system considering 1.8 m apart between each drip irrigation line and 50 cm between row plants, sowing 8 corn seeds per lineal meter (about a population of 90,000 plants per ha). The evaluated super sweet corn F<sub>1</sub> hybrids were: Jubilee Plus, GSS-5865, GSS-5771, GSS-5362, GSS-3381, WSS-1921, GH-2547, and WSS 3681. According to results recorded in this field super sweet corn F<sub>1</sub> Hybrids essay, most Hybrids reached high yield and quality for international market. All hybrids were harvested 65 days after sowing. The super sweet corn hyd. GSS-5362 recorded the longest ear sized 18" (45 cm). Highest sugar levels were recorded up to 19.9 °Brix in GH-2547, and 16 °brigs were recorded in Jubilee Plus, GSS-5865, and GSS-5362 super sweet F<sub>1</sub> Hybrids. Remaining super sweet corn Hybrids reached a range of sugar from 13.8 to 15.3 °brigs. About yield-

ing, the outstanding super sweet corn Hybrids were GSS-5362 and GSS-5865 recording 1,376 and 1,222 ear boxes per hectare respectively. When packing ears, cartoon boxes of four dozens ears capacity were used.

*Specified Source(s) of Funding:* Univ of Sonora

### (076) Field Evaluation of Sweet Corn (*Zea mays* L.) F<sub>1</sub> Hybrids Grown in La Costa De Hermosillo, Mexico

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Fourteen sweet corn F<sub>1</sub> Hybrids were tested in a grower commercial field in La Costa de Hermosillo, Mexico 70 km west far away Hermosillo City during 2006 spring season. A completely randomized experiment design was utilized. The plots were established under a drip irrigation system considering 1.8 m apart between each drip irrigation line and 50 cm between row plants. Eight corn seeds were sowed per lineal meter (about a population of 90,000 plants per ha). The evaluated sweet corn F<sub>1</sub> Hybrids were: Challenger, Shimmer, Krispy King, GSS-4644, GSS-7831, Prime Time, Forever, 4404, GSS-5788, GSS-9377, GSS-1526, Show Case, Prime Plus, and GSS-9299. According to results recorded in this field sweet corn F<sub>1</sub> Hybrids evaluation, most Hybrids reached high yield and quality for international market. All sweet corn Hybrids were harvested 65 days after sowing. The sweet corn Hyd. SS-9377 recorded the longest

ear sized. Highest sugar levels were recorded up to 16 °brigs in Shimmer, Krispy King, GSS-7831, and GSS-9377 F<sub>1</sub> Hybrids. Remaining sweet corn Hybrids reached 13 °brigs. When packing, cartoon boxes of four dozens ears capacity were used. Regarding to crop production, GSS-4644, Krispy King, Shimmer, and Challenger were the most outstanding F<sub>1</sub> Hybrids recording yielding ranging from 907 to 1176 boxes per ha.

*Specified Source(s) of Funding:* Univ of Sonora

### **(077) Field Evaluation of Vermicompost Rates and Cutting Stems in Ampelo Garlic (*Allium ampeloprasum* L.) Cultivar in Sonora, Mexico**

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The garlic is a very important herb in the world wide because its consumption as spice and medicinal properties. In this experiment were evaluated two rates of liquid vermicompost and cutting some stems of ‘Ampelo’ garlic cultivar plants in order to improve garlic bulb diameter and yielding. Liquid vermicompost applications were scheduled considering intervals of twenty days and garlic stem suppression practice was made up at 6 inches (15 cm) tall. A population of 50,000 plants per ha was considered when sowing five cloves per lineal meter. This experiment was carried out in the Agriculture and Livestock Experimental Station of the Univ of Sonora at Hermosillo, Mexico. A completely factorial randomized experimental design was used in this

experiment. The treatments were: 1) Control (no cutting stem), 2) Liquid vermicompost (200 l/ha) (no cutting stem), 3) Liquid vermicompost (200 l/ha) (cutting stem), 4) Control (cutting stem), 5) Liquid vermicompost (400 l/ha) (no cutting stem), 6) Liquid vermicompost (400 l/ha) (cutting stem). The best results of ‘Ampelo’ garlic cultivar were observed on treatment sixth yielding up to 17.5 ton/ha and recording a bulb diameter average of 78.2 mm followed by treatment fourth reaching a yielding of 17.2 ton/ha and recording a bulb diameter average of 75.2 mm. The third treatment recorded a yielding of 16.4 ton/ha reaching a bulb diameter average of 74.5 mm. According to the recorded results, the rate of 400 l/ha of liquid vermicompost and cutting garlic plant stems at 6 inches (15 cm) tall, improved yielding and bulb diameter on ‘Ampelo’ garlic cultivar.

*Specified Source(s) of Funding:* Univ of Sonora

### **(078) Effects of Seasonal Variation on Total Phenolics and Quality Attributes of Eight Specialty Leafy Greens in Colorado**

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Leafy vegetables are particularly good sources of bioactive compounds since in addition to being principal photosynthesis sites, leaves are major accrual areas of metabolites. Plants synthesize various secondary metabolites for functions such as defense mechanisms against insects, pathogens, and photooxidation. Effects of these compounds on human health have been well demonstrated in various retrospective and prospective studies. Among various phytochemicals, dietary phenolics have been of particular interest in recent years due to their contribution to human health and organoleptic attributes of leafy greens. Synthesis of these compounds may vary in response to seasonal variation. This study was designed to investigate the effects of seasonal variation on eight selected specialty leafy greens (arugula, komatsuna, mizuna, pac choi, huazontel, amaranth, tai sai, and red iceberg lettuce). The eight selected taxa were planted in June, mid-July, and September 2008 in triplicate in clay-based soil under high tunnels at the Horticulture Field Research Center of Colorado State Univ. Total phenolics content, total soluble solids, dry weight, texture, and color coordinates of the greens were analyzed after planting trials. Except for one taxon (amaranth), all others were significantly lower in total phenolics in early seasons in relation to mid- and/or late seasons

( $P < 0.05$ ). Comparison of the mid-season and late season crops yielded a similar trend. The majority of mid-season taxa showed significantly lower values of total phenolics compared to late season crops. Among the eight taxa, the difference between early- and late cultivations of red iceberg lettuce were notably high and of practical importance. This taxon showed more than 7 times higher level of phenolics compounds in late planting trials relative to early cultivation. Similar trends were observed for total soluble solids and dry matter of the taxa; six taxa were significantly lower in total soluble solids and dry weight content from the early planting trial relative to mid and/or late season trials. Variation in color and texture analyses was lower among the three planting trials. It could be concluded that, although visual and textural properties of the planted greens were not meaningfully affected by seasonal variation, total phenolics content, total soluble solids, and dry weight of the selected leafy greens varied considerably in response to seasonal production. It appears that greens grown in the late season trial have higher values of total phenolics, total soluble solids, and dry matter relative to early season trials.

*Specified Source(s) of Funding:* Colorado State Univ Agricultural Experiment Station, Project # COL00635

### **(079) Cloning of $\gamma$ -Glutamyl Transpeptidase in Garlic Cloves and Relationship Among $\gamma$ -Glutamyl Transpeptidase and Alliinase Activity, Storage Condition, and Garlic Blueing**

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Garlic blueing occurs when garlic cloves are stored at low temperature with increasing of 1-propenyl cysteine sulfoxide which is related with  $\gamma$ -glutamyl transpeptidase (GGT) and alliinase. Although garlic  $\gamma$ -glutamyl peptide metabolism is important in biosynthesis of blue pigment in crushed garlic, garlic GGTs are poorly characterized. We cloned the partial-length coding region of garlic GGT by homology with onion enzyme. We also stored garlic at 20 °C for 3 months (A), stored garlic at 20 °C for 3 months then transferred to 0 °C for 3 months (B), and stored garlic at 0 °C for 3 months then transferred to 20 °C for 3 months (C) to investigate relationship among GGT and alliinase activity, storage condition, and garlic blueing by RT-PCR. Results showed GGT activity increased in treatment B followed by storage at 0 °C for 3 months, and decreased in treatment C followed by storage at 20 °C for 3 months, whereas alliinase activity was not affected by storage temperature. It indicated that blueing in crushed garlic was affected by storage temperature with increasing GGT activity, not alliinase activity.

### **(080) Carbon Nanoparticles Do Not Affect Germination or Seedling Growth but Affect Fruit Quality**

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Nanotechnology is growing rapidly. Various uses of nanotechnology are being explored in food and agriculture sector. With rapid development of nanotechnology, release of nanoparticles into the environment and contamination of irrigation waters may be inevitable. Both positive and negative impacts of nanoparticles have been reported on plant and animal systems. The objective of work presented here is to assess the impact of nanoparticles may have on growth and development and quality of horticultural crops. In preliminary experiments we incubated pepper seeds in 20 mg/L solutions containing natural organic matter (NOM), NOM + C70 fullerenes or NOM + multi-walled carbon nanotubes (MWCNT). Incubation of pepper seeds with carbon nanoparticles had no impact on germination or growth of pepper seedlings. We observed that pepper seeds absorbed C70 fullerenes through the seed coat during imbibition. As the seedlings grew, fullerenes moved up through the vascular system. As water evaporated, fullerene particles accumulated on stomatal opening. C70 fullerene particles were also found in pepper fruit tissue. Multi-walled carbon nanotubes were not found in leaf or fruit tissues indicating that MWCNT were not transported through the vascular system. In previous studies, cytotoxicity of fullerenes on human and animal cell systems has been reported. Mechanisms of nanoparticle damage to living tissue are unknown but oxidative stress caused by nanoparticles has been proposed as a major cause. Investigations into the impact of nanoparticles in agricultural ecosystems and impact on consumers are warranted.

### **(081) Evaluating the Effect of Nitrogen, Crop Rotation, and Trap Crops on Onion Thrips, IRIS Yellow Spot Virus, and Crop Yield**

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Onion production in the western United States suffers significant damage from iris yellow spot virus (IYSV). Since IYSV is thrips vectored and primary control options include

heavy pesticide use, there has been an increase in pesticide resistance and virus spread. The objectives of this study were to identify crop management strategies to enhance onion productivity and suppress thrips and IYSV. Three fertility programs, two crop rotation schemes and three trap crops were tested for their effects on onion yield, thrips density and IYSV. Thrips adults, nymphs and eggs populations were monitored from whole plant and leaf samples collected in the various N treatments and trap crops. Reduced nitrogen input (134.5 kg N/ha, one-third grower rate), resulted in no significant reduction in yield. There was a decrease in soil microbial activity, as measured by dehydrogenase activity in treatments receiving the high rate of N fertilizer (392 kg N/ha). Both thrips adult and egg densities were greater in onions fertilized with the high N rate, particularly when rotated with wheat. Both lacey phacelia and carrots were more attractive than onions early in the season. However, later in the season, trap crops were less effective in attracting thrips. There were no treatment effects on IYSV infection as measured by ELISA testing; however, overall IYSV incidence was low. Early results suggest that reduced nitrogen input coupled with corn/onion rotation reduced attractiveness of onions to thrips and created a more favorable environment for microbial activity while sustaining onion yields. While the early attractiveness of trap crops looks promising, further investigation is needed to determine if this is a suitable alternative thrips management strategy for onion.

*Specified Source(s) of Funding:* WESTERN SARE

### (082) Rootstock Effects on the Water Relations of Grafted Watermelons

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Watermelons and other cucurbits are susceptible to several root rot, vine decline, and wilt diseases that impact productivity by reducing root capacity for water and nutrient uptake. Grafting susceptible varieties on resistant rootstocks often alleviates this problem; however, graft incompatibility and poor fruit quality have frequently been reported, hence the need to identify alternative rootstocks. The goal of this study was to characterize physiological and growth among watermelon plants grafted on rootstocks from different genera in order to identify traits that may improve drought and disease tolerance. Leaf photosynthesis (Pn) stomatal conductance (gs), transpiration (E), water potentials ( $\Psi$ ), root dry matter allocation, and root hydraulic conductance (Lr) characteristics of five-week old watermelon seedlings (cv 'Super Seedless 7167') grafted on four hybrid squash varieties: *Cucurbita maxima* cv: 'Strong

Tosa', 'RS1330', 'Shintosa Camel', and 'Tetsukabuto'; and a *Lageneria siceraria* variety (cv Pelops) were studied. Leaf water potential, leaf stomatal conductance (gs), transpiration (E) and photosynthesis (Pn) values were significantly higher among grafted plants compared to non-grafted control plants. Root:shoot allometric relationships differed between grafted plants and non-grafted plants, and also among plants grafted on different rootstocks. Non-grafted plants generally had lower root mass allocation coefficients. Plants grafted on 'RS1330' had the highest root dry mass allocation coefficients. The average Lr of grafted plants was significantly greater than that of non-grafted plants. Although biomass allocation to roots was greatest in 'RS1330', Lr values were greatest in 'Tetsukabuto'. Observations of shoot physiological properties ( $\Psi$  and gs) among grafted plants suggest a strong link with the capacity for water flux through root systems of the rootstocks studied.

### (083) High Tunnel Strawberry Production Systems for High Elevations

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A short growing season combined with depressed in-season prices often makes strawberry production in the Intermountain West only marginally profitable. Using high tunnels for early-season extension may allow producers to attract new customers, maintain current customers, and take advantage of higher out-of-season prices. While high tunnels effectively manipulate temperatures, photoperiod also affects flowering and fruiting of fall planted June-bearing strawberry plants. Photoperiod responses can be manipulated by optimizing planting date. Four-week-old 'Chandler' plug plants were transplanted into high tunnels in North Logan, Utah (1405 m elevation, 41°46' N latitude) on each of six different planting dates from 1-Aug. (about 15.4 hr photoperiod) through 16-Oct. (about 10.6 hr. photoperiod) in a raised bed annual hill system. Planting dates were evaluated based on early and total yields the following spring. Planting dates were also evaluated on runner and crown production. The in-ground system was also compared to vertical growing systems with east/west and south orientation. Results from two consecutive years indicate that high tunnels can be used to advance strawberry production by about 4 weeks. Vertical growing systems had only marginally higher yields, but were much more expensive to establish and maintain. A fall planting date of 1-Sept was found to maximize crown numbers at the beginning of the season, minimize runner production, and optimize both early and total yields obtained from high tunnel grown 'Chandler' strawberry plants.

*Specified Source(s) of Funding:* Western SARE

### (084) Nitrate and Iron Concentration Effects on Nitrate and Iron Uptake and Assimilation in *Vaccinium* Species

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Cultivated blueberry (*Vaccinium* species) production is constrained by strict soil requirements for optimal growth, including low pH, high iron, and nitrogen primarily in the ammonium form. Since these types of soils are limited, extensive soil amendments are necessary for good production. *V. arboreum* is a wild species adapted to a broader range of soils that do not require amendments. Our previous work indicates that the wider soil adaptation in *V. arboreum* is correlated with increased efficiency of nitrate uptake/assimilation compared with cultivated *Vaccinium* species. However, the effects of external iron concentration or interactions between nitrate and iron concentrations on uptake and assimilation of nitrate and iron and subsequent growth responses in these species are unknown. To test this, nitrate and iron uptake, and activities of nitrate reductase (NR, the rate limiting enzyme for NO<sub>3</sub> assimilation) and ferric chelate reductase (FCR, the rate limiting enzyme for iron assimilation) were compared in *V. arboreum* and *V. corymbosum* interspecific hybrid (southern highbush blueberry). Plants were grown hydroponically in either 1.0 or 5.0 mM NO<sub>3</sub> with either 0.01 or 0.09 mM Fe. There was no effect of NO<sub>3</sub> or Fe concentration on specific NO<sub>3</sub> uptake or NR activity, although cumulative NO<sub>3</sub> uptake was greater at the higher external NO<sub>3</sub> concentration. Nitrate uptake and NR activity were greater in *V. arboreum* compared with *V. corymbosum*, and this was reflected in an increase in plant DW of *V. arboreum* at the higher external NO<sub>3</sub> concentration compared with the other treatments. Root and leaf FCR activity and iron uptake were significantly higher in *V. arboreum* than in *V. corymbosum*. Total iron concentration in roots was higher in *V. arboreum* compared with *V. corymbosum*, but concentrations in stems and leaves were similar between the two species. On the other hand, concentrations of “active” or loosely bound iron were higher in *V. arboreum* organs, especially at the lower external iron concentration. *V. arboreum* appears to be more efficient in assimilating both nitrate and iron compared with *V. corymbosum*, possibly due to increased NR and FCR activities, and this may partially explain the wider soil adaptation of *V. arboreum*.

### (085) Allyl Isothiocyanate Reduces Fruit Decay of Blueberries by Paradoxically Generating Reactive Oxygen Species

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The effect of allyl isothiocyanate (AITC) on flavonoids, radical scavenging capacity, decay and fruit quality of blueberries var. Duke (*Vaccinium corymbosum* L.) was evaluated. Results from this study showed that AITC was effective in retarding blueberry decay during storage at 10 °C. However, AITC decreased the content of total phenolics and anthocyanins, as well as antioxidant capacities. Compared to controls, AITC-treated berries had lower scavenging capacities against free radicals of oxygen radical absorbance capacity (ORAC), hydroxyl radical scavenging capacity (·OH) and 2, 2-Di (4-tert-octylphenyl)-1-picrylhydrazyl (DPPH), but promoted the accumulation of H<sub>2</sub>O<sub>2</sub> radicals. The free radical scavenging properties of blueberry fruit with or without AITC treatment were also evaluated by electron spin resonance (ESR). Results of the ESR measurements confirmed that free radical scavenging capacities against ·OH, DPPH and O<sub>2</sub><sup>·-</sup> were lower in treated fruit than in controls. AITC treatments also reduced the amount of phenolic acids and anthocyanins during storage at 10 °C. The results from this study indicate that AITC does not promote antioxidant properties or scavenging of constitutive reactive oxygen species (ROS), but paradoxically generates additional amounts of ROS to inhibit the growth and proliferation of microbial cells, thereby reducing decay in fruit tissue.

*Specified Source(s) of Funding:* Government

### (086) Analysis of Cellular Basis of Fruit Size Variation in Rabbiteye Blueberries (*Vaccinium ashei*)

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Fruit size is a valuable commercial trait in crops such as blueberry. In spite of its importance, little is known regarding the mechanisms involved in regulating fruit size. In this study, we investigated the basis of variation in fruit size across rabbiteye blueberry genotypes. Twenty rabbiteye blueberry cultivars and advanced selections from the Univ of Georgia blueberry breeding program were used in this study. At harvest, fruit weight, fruit diameter, cell number and cell cross sectional area were determined in the above genotypes. Fruit weight varied over a 3-fold range from 0.9 g to 2.8 g while fruit diameter, at the widest part of the fruit, ranged from 11.5 mm to 18.8 mm. Varieties such as ‘Brightwell’ and ‘Powderblue’ constituted the lower range of fruit weight and fruit diameter, while advanced selections such as T-959, T-960 and T-965 constituted the upper range. Fruit weight and fruit diameter were significantly related ( $r^2 = 0.97$ ;  $P < 0.001$ ) indicating that fruit diameter is a good predictor of fruit weight in rabbiteye blueberries. Cell number and cell area were determined by sectioning fruits using a vibratome followed by image analysis using ImageJ (NIH). While little variation in cell cross sectional area was observed, cell number varied by almost 2.5-fold among the 20 genotypes. Cell number was

strongly related to fruit diameter ( $r^2 = 0.77$ ;  $P < 0.001$ ) while no significant relationship between cell cross sectional area and final fruit diameter was observed. Additionally, cell number and cell cross sectional area were not significantly related. These data indicate that variation in fruit size across rabbiteye blueberry genotypes is largely facilitated by variation in cell number. To determine if difference in cell number between large fruit-size and small fruit-size genotypes was due to differential cell production during fruit growth, cell number at bloom and at harvest were measured in 'Powderblue,' a small fruit-size variety, and T-959, a large fruit-size selection. Cell number at bloom in 'Powderblue' was not significantly different from that in T-959. In 'Powderblue' cell number at harvest was not significantly different from that at bloom, but in T-959, cell number increased by ~1.75-fold during fruit development. These data indicate that larger fruit size in rabbiteye blueberries is facilitated by increased cell production during fruit development.

*Specified Source(s) of Funding:* USDA-CSREES

**Tuesday, August 3, 2010** **Springs F & G**  
**Genetics/Germplasm/Plant**  
**Breeding: Fruit/Nut Crops 1**

**(019) A SSR Marker Linked to the Susceptibility to *Alternaria mali* in Apple**

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*Alternaria mali* is a leaf pathogen in apple, and causes leaf spots, and premature drop when serious. This disease is of worldwide importance, but is most serious in the East Asia (Japan, Korea and China). The wide use of fungicides not only adds cost to farmers, but also pollutes the environment. The objective of this study was to characterize a 5-year  $F_1$  population from a cross of a resistant cultivar ('Huacui') and a susceptible cultivar ('Golden Delicious'), consisting of 110 individuals, along with 10 each of mature parent trees (14 years old). A field survey of disease severity was conducted in 2008 and 2009 under the natural condi-

tions in the experimental orchard of the Xingcheng Institute of Pomology (Xingcheng, Liaoning Province, P.R. China, 40°37'N, 120°44' E). The average disease index of the  $F_1$  population was higher than the mid-parent value, suggesting that resistance to *Alternaria* may be controlled by a major gene in combination with some minor genes. Artificial inoculation was also done both on the living trees and on the detached leaves in 2009. The different inoculation procedures produced different types of disease spots and color features. Based on the field data, 110  $F_1$  plants were divided into susceptible and resistant groups, and genomic DNA were extracted and pooled. Eighty primer pairs (Simple sequence repeat-SSR markers) were screened against the two DNA pools, and one pair, namely CH05g07, was showed to be linked to the susceptible DNA pool. This primer pair was used to screen all individual 110  $F_1$  progenies and two parent trees. The differentiation of 93 individuals (84.5%) with the marker matched with the field disease resistance rating. This marker was further screened with 20 cultivars with known susceptibility or resistance and its linkage to susceptibility was validated. These results suggest that this marker can be used in marker-assisted selection for resistance/susceptibility to *Alternaria* leaf spot disease.

*Specified Source(s) of Funding:* National High Technology Research and Development Program of China

**(020) *Agrobacterium*-mediated transformation of antifreeze protein gene in 'Kyoho' and 'Cabernet Sauvignon' Grapevines (Transformation of Grapevine)**

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The optimum condition for shoot regeneration from leaf explants of grapevine cultivars 'Kyoho' and 'Cabernet Sauvignon' were investigated and it was originating from in vitro cultures were transformed. It was transformed with *Agrobacterium tumefaciens* strain LBA4404 harboring a binary vector pBI121, which contained a neomycin phosphotransferase II (*NPTII*) gene and *AFP* gene encoding antifreeze protein from carrot. The explants were co-cultivated for 3 days with recombinant *Agrobacterium* and then selection on Murashige and Skoog (MS) basal medium supplemented with concentrations of 5 mg/L Thidiazuron (TDZ), 0.1 mg/L Indole-3-Butyric Acid (IBA), 100 mg/L kanamycin and 500 mg/L carbenicillin. Successful regeneration of transgenics were obtained. PCR analysis were verified the integration of the antifreeze protein (*AFP*) and neomycin phosphotransferase II (*NPTII*) genes into genomic DNA.



**(021) Comparison of Four Strains of 'Fuji' Apple**

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The purpose of this study was to evaluate four new strains of 'Fuji' for growth, production and fruit color. The strains were 'Mira', 'Sun', 'BC#2' and 'Yataka'. The trees were planted in 1998 on M.9 rootstocks in a randomized complete block with ten replications. At the end of the 2007 growing season the largest trees as measured by trunk cross sectional area were the 'Mira' and significantly larger than trees of 'Sun' or 'Yataka' strains. 'Mira' produced significantly greater cumulative number of fruit than trees of 'Sun' but not significantly greater than the other two strains. There was no significant difference in cumulative yield between strains. Average fruit weight for 1999 through 2007 was greatest for 'BC#2' followed by 'Yataka' and 'Sun' strains. Cumulative efficiency was greatest for the 'Yataka' strain and least for the 'Mira' strain. Color was measured in three seasons on the three later maturing strains. In 2001 there was no difference in L, chroma and hue angle values between the three strains. However, in 2004 and 2005 'Sun' had significantly lower L and chroma values than those of 'BC#2' and similar values to 'Mira'.

*Specified Source(s) of Funding:* State Horticultural Association of Pennsylvania

**(022) Characterization of Mamey Sapote  
[*Pouteria sapota* (Jacq.) H.E. Moore & Stearn.]  
Germplasm at the USDA-ARS Tropical  
Agriculture Research Station**

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The mamey sapote (*Pouteria sapota* [Jacq.] H.E. Moore & Stearn) is a tropical tree fruit in the Sapotaceae, which is native to Central America and southern Mexico. The tree is used for timber and shade; however it is the sweet, nutrient and vitamin rich fruit that is eaten out of hand, in milkshakes, sherbets

or ice creams, that is most prized. An *ex situ* collection of twenty-six mamey sapote accessions at the USDA-ARS TARS (Tropical Agricultural Research Station) in Isabela, Puerto Rico was evaluated for horticultural and agronomic traits over a 3-year period. Six-year-old, clonally propagated trees that were regularly irrigated, fertilized and pruned were used for the evaluation. Fruit was collected during monthly harvests and a subset of randomly selected fruit for each accession, at each harvest, was analyzed in the laboratory. Generally, production (number and total weight of fruit per tree) was highest in the summer months (May to August); however, some accessions produced more during the winter and spring months (December to April). 'Viejo' was the most productive accession; yielding and average of 70 fruits/tree/year however, fruit size was very small averaging only 294 g/fruit. In contrast, 'Adelantado #2' only produced 45 fruits/tree/year, but because of its larger fruit size (621 g) it ranked highest for total fruit weight. The range in average fruit size, length, width, mean seed number, as well as mean exocarp weights was considerable and influenced the amount of pulp for each accession. Total soluble solids (°Brix) among accessions ranged from 18.7 to 27.7. Phenotypic traits measured included fruit shape, measured by a length/diameter ratio that ranged from 1.10 (globular) to 1.71 (elliptical) and exocarp texture which was generally coarse to very coarse, the exception being 'Tazumal' with a smooth surface. Several of the accessions evaluated have shown potential for use in breeding programs and/or as cultivars for industry either for fresh or processed fruit. Considerable variation in traits measured among the accessions could be an indication of significant genetic diversity, something that is being currently evaluated with molecular markers.

*Specified Source(s) of Funding:* USDA

**(023) Pear Psylla Resistance in Breeders  
Selections**

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Twenty pear cultivars and breeders' selections with interspecific pedigrees involving *Pyrus ussuriensis* Max. or *P. pyrifolia* (Burm.) Nakai crossed with *P. communis* were assessed for resistance pear psylla (*Cacopsylla pyricola* Foerster) using a nymphal feeding antixenosis assay. Four *P. ussuriensis* × *P. communis* hybrid selections (NJ B9 R1 T117, NJ A2 R21 T89, NY 10355 and NY 10359) and one *P. pyrifolia* × *P. communis* hybrid selection (NJ Rock R25 T238) were significantly less susceptible than Bartlett (*P. communis*). Fruit size and quality of the resistant selections varied, and while inferior to pure *P. communis* cultivars, should be valuable genetic resources for the breeding of new pear cultivars with resistance to pear psylla.

*Specified Source(s) of Funding:* USDA-ARS CRIS 1931-21000-017-00D

## Tuesday, August 3, 2010 Springs F & G Herbs, Spices & Medicinal Plants

### (287) An Emerging Specialty Crop: *Cannabis* Cultivation in Colorado

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At varying levels, medical marijuana has now gained legalization in 14 U.S. states. Other than California, few states have been as aggressive working with this new growth industry than Colorado. Colorado statistics indicate over 20,000 people are on the waiting list with similar statistics already holding Colorado Medical Marijuana Patient Registry cards (MMJ) under Colorado's Amendment 20 (TIME, 8 Mar. 2010, p.6.) The constitutional amendment approved by voters in 2000 allows people with cancer, glaucoma, HIV, AIDS, muscle spasms, severe pain, severe nausea and other medical conditions to use marijuana. In Oct. 2009 the Federal Justice Department stated it would refrain from prosecuting medical marijuana cases resulting in an explosion of dispensaries where patients can obtain pharmaceutical-grade marijuana. Yet, who is minding the store or in this case the grow room? This is a new horticulture industry that lacks professionals or even professionals to mentor the MMJ growers. How will appropriate standards of practice and other horticulture-related issues be determined? Who will do it? This study will present an update for this emerging specialty crop as well as a report on the success of a 30-hour MMJ Specialty Crop Short Course.

*Specified Source(s) of Funding:* Private

### (288) Influence of Nitrogen and pH on Constituent Levels and Plant Growth of Greenhouse-grown *Echinacea purpurea*

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*Echinacea purpurea* is one of the most popular medicinal herbs with annual sales in the United States of over \$120 million.

Although commonly used for the treatment of colds and flu, results from numerous studies on its effectiveness have been inconclusive. Consistency of raw material used to make products and positive identification of the bioactive constituents are two issues that must be addressed before reliably effective *E. purpurea* preparations can be developed. A study was conducted to determine whether levels of several chemical constituents in *E. purpurea* can be manipulated by changing soil pH and nitrogen. Plants were grown in soilless media in pots in the greenhouse. The experimental design was a RCB factorial with three initial soil pH levels (5.85, 6.35, and 7.0) and three nitrogen rates (50, 100, and 200 mg N/kg media). There were nine plants in each treatment. Two plants were harvested from each treatment at three different stages of growth (emerging, flowering, and post-bloom). Extra plants were produced to ensure that two plants at the same stage of growth could be harvested on the same day. Roots were washed and dried at 38 °C under positive air flow. The dried roots were pulverized, extracted in 75% ethanol, and analyzed for active constituents using reversed phase HPLC coupled with electrospray ionization mass spectrometry. Plants responded to increasing nitrogen with more vigorous growth, greater numbers of blooms, and higher total biomass. Soil pH, however, had little effect. Laboratory analysis revealed that none of the factors affected concentrations of one of the major alkylamides of interest, dodeca-2E,4E,8Z,10E-tetraenoic acid isobutylamide. Interestingly, the outcomes from parallel studies with isolated alkylamides and ethanolic alkylamide containing extracts suggested that this compound may play an important role in the anti-inflammatory activity of *Echinacea*. Therefore, it appears that it is possible to manipulate growing conditions to boost production of *Echinacea* without compromising production of one of its anti-inflammatory constituents (dodeca-2E,4E,8Z,10E-tetraenoic acid isobutylamide). Based on these findings, *Echinacea* growers may want to increase nitrogen fertilization to increase total plant yields.

*Specified Source(s) of Funding:* Univ of North Carolina Research Competitiveness Fund

### (289) Effect of Plant Hormones on Productivity of Peppermint and Spearmint

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Peppermint (*Mentha × piperita* L.) and spearmint (*Mentha spicata* L.) are major essential oil crops in the US and worldwide. The objective of this controlled environment study was to evaluate the effect of three plant hormones (salicylic acid SA, methyl jasmonate MJ, and gibberelic acid GA<sub>3</sub>, each at 10, 100, and 1000 mg/L, applied as a foliar spray), on biomass yields, essential oil content and oil yields of peppermint and spearmint. Overall, the

application of SA at 1000 mg/L increased biomass yields of both mints relative to the control, while the other treatments were not significantly different from the control. The essential oil content was higher in peppermint than in spearmint, and treatments had different effect on the two mint species. The application of MJ at 100 and 1000 mg/L, GA at 10 mg/L, SA at 10 and at 100 mg/L, increased the essential oil content of peppermint, while the oil content of spearmint was not affected by treatments. None of the treatments reduced essential oil content relative to the respective controls. The overall essential oil yields (function of biomass yields and essential oil content) were also differentially affected by the treatments in the two mint species. The application of MJ at 100 mg/L and SA at 100 mg/L increased essential oil yields of peppermint, while the application of SA at 1000 mg/L increased oil yields of spearmint. Treatments did not reduce essential oil content or oil yield of either mint species. This study demonstrated that plant hormones may be used as a tool for increasing essential oil content and essential oil yields of peppermint and spearmint crops. Further research is needed to elucidate the effect of these treatments on essential oil composition and to verify the effects under field conditions.

*Specified Source(s) of Funding:* Special Research Initiative, Mississippi State Univ

## Tuesday, August 3, 2010 Springs F & G Marketing/Consumer Horticulture

### (127) Advanced Sensing and Management Technologies to Optimize Resource Use in Crops. I

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Currently, the application of fertilizer and water in orchard crops follows largely standardized practices with limited consideration of temporal, climatic and crop variability. This approach constrains our ability to improve management, results in loss of potential income and causes negative environmental impact. We strive to address this issue by integrating 1) new approaches to determine crop demand with spatial and temporal accuracy, with 2) advanced methods of estimating current crop status and performance with 3) the development a new site specific orchard management platform. In this poster (#1 of 2), we discuss integrated approaches to define real time crop 'demand' for water and nutrients with high spatial and temporal demand for water and nitrogen by deciduous perennial crops. In a partner poster we present advanced methods for crop 'status' determination. A series of 8 research sites were established in 2008 throughout California, New Mexico and Texas in Almond, Pistachio and Pecan. Fertilizer rate trials and nutrient monitoring (all essential elements) in plant, soil, and crop are being used to construct nutrient budgets with a high degree of spatial and temporal specificity. Water demand is being estimated with a number of redundant models and with real time monitoring of plant, soil and atmospheric parameters. Yield prediction and nutrient and water demand models are under development through the integration of multi-year yield monitoring in a large number (>1,500) individual trees. Fertilizer rate trials and irrigation treatments have been established to develop response curves and interaction required for model refinement. Preliminary results will be presented on the following: Whole tree nutrient budgeting Temporal pattern of nutrient uptake annually Within tree nutrient partitioning Yield estimation modeling Comparative analysis of soil, plant and model based determination of water demand

*Specified Source(s) of Funding:*

### (128) A Comparison of Purchasing Behavior and Recognition of Invasive Plants by Gardening Consumers and Master Gardeners in New Jersey

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The sale of horticultural plants has played a significant role in the introduction and spread of invasive plants in North America. The purchase of invasive plants by home gardeners can have serious long-term effects on the ecology of wooded areas and open space. A survey was conducted of New Jersey residents in 2008 and 2009 to assess their perception of invasive plants and to document their purchasing behavior. Eight hundred and seventy-four consumers participated in the survey; 421 randomly selected gardening consumers and 453 Rutgers Master Gardeners. Each participant was shown labeled photos of twelve plants and was asked whether they believed the plant was invasive, non-invasive or they were unsure. The survey participants were offered a definition of invasive based on the 2004 New Jersey Executive Order. The participants were also surveyed to rate factors that influence their purchase of landscape plants, which included price, quality, pest resistance, deer resistance, plant origin and invasiveness. Both groups, consumers and Master Gardeners, rated English ivy (*Hedera helix*) the highest percentage for invasiveness; 81% and 83%, respectively. Similarly, 52% of the respondents from each group rated porcelain berry (*Ampelopsis brevipedunculata*) as being invasive. Master Gardener participants showed a greater response for the invasive potential of nine of the twelve featured species compared to the general public. Seventy-one percent of the Master Gardeners regarded Japanese barberry (*Berberis thunbergii*) as invasive compared to 60% of the consumers surveyed. Master Gardeners also rated high invasive potentials for Norway maple (*Acer platanoides*) 67%, burning bush (*Euonymus alatus*) 59% and butterfly bush (*Buddleia davidii*) 63% compared to the consumer group's response of 39%, 31% and 35% respectively. Survey results regarding purchasing behavior were similar for both groups with 79% of the surveyed consumers selecting non-invasive plants while 84% of the Master Gardeners chose non-invasives. Twelve percent of the Master Gardener respondents spent five hundred dollars or more annually on landscape plants while 17% of the consumers spent this amount. The findings from this survey showed that while both groups sought to make responsible plant purchases with regard to disease, insect and deer resistance, water conservation and maintenance requirements; trained Rutgers Master Gardeners showed overall higher recognition of invasive species that are problematic in New Jersey. They also reflect that consumers feel they are choosing non-invasive plants when in fact they cannot readily identify plants with invasive qualities.

*Specified Source(s) of Funding:* Department, College, State and/or HATCH

### (129) Organic Crop Practices, Knowledge, Perceptions, and Preferences: A Survey of Producers and Consumers

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Consumers' demands for organic crops continue to rise at the regional and national levels in the USA as people become more conscious about the quality of the food they eat. The purpose of this project was to determine the practices, knowledge, perceptions and preferences of stakeholders in the 14 counties of the Delmarva Peninsula which includes the entire State of Delaware, and portions of Maryland, and Virginia. Therefore, an 18-question survey was developed and tested with 50 self-convenient participants recruited during the small farm conference at UMES in fall 2008. The surveys were revised and mailed in spring 2009 to 300 stakeholders using the small farm conference list serve. A total of 70 surveys were returned. The respondents were from the 14 counties of the Delmarva Peninsula and five other neighboring counties (3 in Maryland, 1 in Virginia and 1 in Pennsylvania). Data were analyzed using SPSS 17.0. Descriptive statistics and cross tabulation were computed. About 51% of the respondents were 24 to 54 years old and 49% were 55 years or older. Most of the respondents (72%) were engaged in farming which included crops and livestock. Fewer than 30% of the farmers grew both organic and inorganic crops, and less than 10% grew organic alone. Growers of organic foods produced an array of fruits, vegetables, herbs and raised some animals. Ten to 15% of these growers produced tomatoes, peppers, cucumbers, green beans, watermelons and cucumber organically. At least a half of the producers were knowledgeable about production costs, marketing, farming practices for crop safety, and quality of organic crops, while fewer than 50% knew about the practices for growing certified organic. Lack of time and the time to certify for organic farming were the two most cited reasons for farmers not growing organic. Both the farmers and non farmers believed that organic crops are safe, high quality and high cost. Those farmers who were not involved in organic production indicated their desire of doing so. Opinions and knowledge are disparate among the Delmarva stakeholders. Thus, there is a need to provide the farmers with more information on how to grow and market organic produce, and also the cost involved.

*Specified Source(s) of Funding:* Evans Allen

### **(130) Locally Grown Ethnic Greens and Herbs: Demand Assessments and Production Opportunities for East Coast Farmers**

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This study primarily focuses on estimating consumer demand for ethnic greens and herbs, willingness to pay a premium for fresh leafy greens and herbs, document preferences for local produce and demographic characteristics of ethnic consumers'. The first phase of the project documents the consumer buying patterns relating to ethnic greens and herbs using Internet Bulletin Board focus group meetings. Four separate Internet bulletin board sessions were conducted to better understand consumer use of ethnic greens and herbs and perceived quality, price, and availability. Each of the two-day sessions, conducted from March 10 to 12, 2010, included eight to 12 consumer panelists who identified

themselves with one of four ethnic groups: Asian Indian, Chinese, Mexican, or Puerto Rican. Panelists participated if they met the screener criteria: belonged to one of the ethnic groups of interest, primary grocery shopper, living within the East Coast region of the U.S., and at least 18 years of age. The Internet bulletin board methodology was chosen to allow panelists to respond to a variety of questions, posed by researchers, and respond to other panelists' submissions. Groups were segmented based on ethnicity in order to ascertain any issues related to specific cultures' use of ethnic greens and herbs and whether authentic products were available. Overall, availability of ethnic greens and herbs depended on panelists' location. As might be expected, panelists who mentioned residing in more metropolitan areas expressed that they had access to ethnic greens and herbs, and through at least one outlet. Others replied that certain greens and herbs were difficult to find locally. A minority of panelist reported traveling distances up to 40 miles from their residence to purchase such ingredients. Availability of ethnic markets, product quality and freshness, and price influenced their purchasing decisions. For those who were able to compare conventional grocery stores with ethnic markets, they noted that greens and herbs tended to be higher quality and, since they believed stock rotated more frequently at ethnic markets, were fresher and priced lower. While a few panelists provided prices for items sold at ethnic markets, compared to conventional grocery stores, most of the panelist either believed prices were lower. These responses will be used to construct a telephone survey of ethnic consumers matching the criteria stated above. Data from both studies will provide growers and retailers with information vital for meeting demand and exceeding the needs of ethnic consumers they serve.

*Specified Source(s) of Funding:* Specialty Crop Grant

### **(131) "Gardening through the Seasons" Videos: Seasonal Tips in a Quick, Accessible Online Format**

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As the demand for home horticulture information continues, using technology to help meet this demand is a must. To provide seasonal home horticulture information in a quick and accessible online format, an agreement was reached with the Agricultural Communications Department to produce 24 five minute videos. These videos were designed to provide seasonal tips, techniques and how-to's for the home gardener. MSU horticulturists provided information on everything from how to prune a crapemyrtle to interior plant care. Two videos were produced and posted each month on the Extension Service homepage at <http://msucares>.

com/gardenvideos. These videos could be viewed on the website or downloaded as an MP4 file. The “Gardening Through The Seasons” project and has been very successful. County offices and clientele have indicated these have been very useful when answering seasonal home gardening questions. A DVD of the 24 videos produced in 2009 was provided by request to county offices and other interested gardening groups. Because of the impact and success of this project it was continued into 2010.

### **(132) Utilizing Web-based Survey Tools to Assess Knowledge and Support for Cooperative Extension and Local Agriculture**

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For the past nineteen years, the Rutgers New Jersey Agricultural Experiment Station (NJAES) Snyder Research and Extension Farm has hosted “The Great Tomato Tasting,” (<http://snyder-farm.rutgers.edu/>), a consumer outreach and farm open house to address consumer agricultural and horticultural education needs. These open houses strive to increase public awareness, appreciation and education of proper horticulture techniques, NJAES research, and of local agricultural products, farms, and farmland preservation efforts. The programs feature informal tastings of seasonal produce and more formal research evaluations of produce from experimental plots. Wagon tours led by farm staff and NJAES researchers highlight ongoing Rutgers NJAES agricultural and horticultural research trials. Master Gardener volunteers from surrounding counties participate by answering visitors gardening questions and serving more than 80 varieties of heirloom and hybrid tomatoes grown on the farm. This event attracts more than 1,500 visitors for the four-hour open house. Previous attempts at conducting surveys completed during the event were of little value due to low return rates. Following

the open houses in both 2008 and 2009, a visitor survey was developed utilizing Survey Monkey® online resources, <http://www.surveymonkey.com>. A 10-question multiple choice survey was developed which also included some open ended comment sections. The unique survey web link was then distributed via emails that were collected as part of the event registration. In 2008, the survey was emailed to 400 addresses, while in 2009, 668 e-mail addresses received the survey. The response rate in 2008 was 61.8 % and 35.9% in 2009. This decline in response rate might be attributed to the fact that many attendees are repeat visitors each year. In both years (2008, 009) a majority of respondents agreed or strongly agreed that they had increased their understanding of Rutgers, NJAES Cooperative Extension and its programs (89%, 90%), improved their gardening knowledge (65%, 65%), their awareness of local produce varieties and availability (78%, 79%), and favored efforts for farmland preservation and agricultural viability (90%, 91%). With appropriate questions and proper timing following large educational public events such as the Great Tomato Tasting, Web-based surveys appear to be an effective and efficient tool to measure outreach impact and public opinion.

### **(133) Factors Influencing Consumer Behavior When Purchasing and Consuming Apples**

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The aim of this study was to explore those factors and their importance that might have influence on consumers’ behavior when buying and consuming apples. Untrained consumer panels were organized where consumers were asked to rate the importance of twelve factors listed on a questionnaire (appearance, taste, cultivar name, origin, production method, growing area, sales place, price, advertisement, package size, labeling and season). Consumers were also asked about background information about themselves (age, gender, profession, annual household income, frequency of apple consuming, etc.). For the participants asked the taste seemed to be significantly the most important factor that influences their apple purchasing behavior. Price, fruit appearance, season and the growing area were also important but at a lower level. Further decreasing importance of the following attributes was seen: production method, sales place, name of the cultivar, labeling, origin and package size. Seemingly no special importance was given to the advertisement. No close correlation was found between annual household income and importance score given to apple price. Although very close relationship was not found between age and apple eating frequency, it was clear from the data that younger consumers eat apples more often than do older ones. The eating frequency of apples was not strongly influenced by the price. Consumers that eat apples daily or almost never gave the highest importance scores for apple price.

*Specified Source(s) of Funding:* NCR SARE Grant

### (134) Successes and Perceived Obstacles in Local and Community Food Production in Georgia

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The interest in local sustainable food production systems, including community gardens, community-supported agriculture, and production for local farmer markets, co-ops, and grocery stores, has grown in communities across the United States. The establishment and expansion of local food initiatives in Georgia has been slower than in many other areas of the United States but interest has been increasing exponentially in recent years. Organizations such as Georgia Organics are working to integrate sustainable and locally grown food into the lives of all Georgians. The most recent Georgia Organics conference in March of 2010 had more than 1000 participants. Farmers markets in Georgia have increased from 9 in 2003 to 62 in 2008. At the Univ of Georgia, an organic production certificate program was recently initiated. Local food production in Georgia has been centered in the Atlanta metropolitan area, but residents in communities all over the state are seeking ways to increase access to high quality local food. Nationally, availability and price are most often associated with limiting access to organic produce. The warm, humid climate of Georgia increases pest pressures which can further limit the variety and increase the cost of locally produced organic fruits and vegetables. Other obstacles such as legal barriers may also limit development of local food systems in Georgia. The Cooperative Extension Service of the College of Agricultural and Environmental Sciences at the Univ of Georgia is committed to providing programs and information to assist individuals and communities with developing sustainable food production systems. In order to assess the needs for information and assistance, a survey was conducted of extension personnel, growers, and organizations throughout the state who are involved with sustainable food production. The results of the survey will be presented.

*Specified Source(s) of Funding:* Univ of Georgia

**Tuesday, August 3, 2010** **Springs F & G**  
**Ornamentals/Landscape & Turf**

### (320) Effect of Previous Flood Exposure on Subsequent Flood Tolerance and Growth of Three Native Landscape Shrubs

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Plants in rain gardens encounter repeated periods of flooding. Research was conducted to determine if flooding pre-conditioning during production could affect subsequent flood tolerance outdoors. Plants of *Ilex glabra* (L.) A. Gray. 'Shamrock' (inkberry holly), *Itea virginica* L. 'Henry's Garnet' (sweetspire), and

*Viburnum nudum* L. 'Winterthur' (possumhaw) were potted in 2.5-L (trade gal) pots in 5:3:1 pine bark:peat:perlite (PB) or sterilized field soil, placed in a greenhouse in Feb. 2009, and subjected to 0 (non-flooded), 3, or 6 days of flooding. Following flooding, plants were allowed to drain for six days and received no irrigation. Flooding followed by draining was repeated a total of 7 and 5 flood times for plants in the 3 and 6 day flood lengths, respectively. Non-flooded plants were hand-watered as needed. Flooding was discontinued in the greenhouse, and the plants were then planted outdoors in 171 L (45 gal) tubs. Plants in PB in the greenhouse were planted in the same substrate outdoors. Plants in soil in the greenhouse were planted in calcined clay outdoors. Three plants (same taxon), one each that had been flooded for 0 (non-flooded), 3, or 6 days in the greenhouse were planted per tub. Outdoor flooding treatments were the same as greenhouse flooding treatments and were randomly assigned to each tub. Thus outdoor flooding treatments were in a factorial combination of greenhouse flooding length and outdoor flooding length. Relative growth indices were calculated separately for the greenhouse (RGIg) and the outdoor (RGIo) portions of the study. RGIo of *I. glabra* 'Shamrock' was similar among all flooding length combinations in both substrates suggesting tolerance of flooding at any stage regardless of preconditioning. RGIo of *I. virginica* 'Henry's Garnet' was higher in PB if plants had been previously flooded in the greenhouse but was not affected by any flooding treatments in CC. RGIo of *V. nudum* 'Winterthur' was only affected by outdoor flooding length. RGIo of *V. nudum* 'Winterthur' in PB was highest for plants that were non-flooded outdoors; in CC RGIo was highest in plants that were flooded for 6 days outdoors. Flooding during production does not appear to be critical to flood tolerance for these taxa, particularly since all plants continued to grow throughout both phases of the experiment, and survival rate was 100%. Visual quality of all plants was also high, suggesting that all three taxa would be suitable for use in rain gardens.

### (321) Growth and Physiology of Deciduous Shade Trees under Varying Irrigation Regimes

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Reduced water availability and increased cost of water have caused nursery producers to rethink water management practices.

High-value container grown crops require frequent irrigation to optimize plant growth, and container production of high-value crops, like landscape trees, is increasing relative to field production. Irrigating cyclically, or applying daily water allotments in multiple irrigation events, instead of the traditional once daily application method may lead to increased tree growth and decreased water use. The objective of this study was to quantify the effects of varying irrigation regimes on the growth and physiology of common landscape shade tree species in Pot-in-Pot (PiP) production. Seven species were grown in #25 containers and randomly assigned to irrigation regimes with varying combinations of volumes (low or high) and cycle frequencies (once or 4 times daily). Daily water allowances were based on 75% or 150%  $ET_0$ , and water was applied using pressure compensating spray stakes. Mid-day gas exchange, stem caliper, and tree height were measured monthly in 2008 and 2009. Diurnal gas exchange and water potential of two species were measured on two dates during each growing season, and substrate media temperature and moisture were monitored on one block throughout the study. Trees were more responsive to irrigation rate than cycle frequencies. Across all species, trees receiving the high water volume had greater height and stem radial growth, net assimilation ( $A$ ), and stomatal conductance ( $g_s$ ) than trees irrigated with the low volume. A strong species response was observed in most growth and physiological variables. Within species, the difference in stem radial growth between trees irrigated at the high volume and trees irrigated at the low volume was greater in year two than year one. Cyclic irrigation increased height growth in 2009 only in 'Ulmus 'Morton' compared to trees irrigated only once daily. Response of tree WUE, calculated as  $A/g_s$ , was dependent on date of sampling. Trees irrigated with four cycles had higher WUE than trees irrigated with one cycle on only one sampling date in the 2009 season (14 May). Irrigating cyclically decreased the amplitude of daily fluctuations in substrate moisture. Differences in growth and physiological responses to treatments could be due to inherent differences in species morphology, tree size, and growth rate.

*Specified Source(s) of Funding:* Michigan Ag Experiment Station Project GREEN Michigan Department of Agriculture Horticulture Fund

### (322) Effects of Trinexapac-ethyl on Growth and Development of Three Ornamental Grasses

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Ornamental grass sales have drastically increased over the past decade. As a result, nursery production of grass species has increased to accommodate the increased demand. In production, ornamental grasses are fast growing which leads to increased space requirements and large quantities of water and fertilizer. This research evaluated the effects of trinexapac-ethyl (TE), a gibberellin inhibitor, on growth of ornamental grasses. Growth parameters evaluated in this study included plant height, tiller production and chlorophyll content (SPAD) in three ornamental grasses *Miscanthus sinensis* 'Variegatus', *Pennisetum xadvena* 'Rubrum' and *Calamagrostis xacutiflora* 'Karl Foerster'. Grass plugs were potted in a pine bark medium in 3.8 L containers and topdressed with 15g Osmocote 15-9-12 (Scott's, Marysville, OH) per container. Plants were irrigated as needed with clear water. Grasses were grown in full sun in Starkville, MS and treated 10 days after planting with 0, 132.4 mg, 220.7 mg, or 308.9 mg  $TE \cdot L^{-1}$  with a second application 42 days after initial treatment. Reduction of plant height was detected in all cultivars evaluated, but the most significant reduction resulted from the second application. Tiller production in *C. xacutiflora* 'Karl Foerster' decreased with increasing TE rate while *M. sinensis* 'Variegatus' increased tillers with increased TE rate. In *C. xacutiflora* 'Karl Foerster' SPAD readings increased with increasing TE rate. Although the growth parameter effects were species and cultivar dependent, TE when applied to ornamental grasses has the potential to increase nursery production efficiency by reducing plant growth rates and increasing chlorophyll content.

### (323) Effect of Nutrient Level on Production of Mixed Species Green Roof Modules

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Green roofs, rooftops that are vegetated, are desirable for their numerous environmental benefits. The sedum vegetated green roof modular system is gaining popularity as a green roofing method due to its ease of delivery and installation and immediate rooftop aesthetic value. Sedum plants are tolerant of adverse rooftop conditions including drought, high heat, direct sunlight, wind and snow load. The expanding green roof market and high demand for modules has created a situation where current module production methods are unable to meet demand. The influence of two different rates of control release fertilizer (30 g and 70 g of Scott's Osmocote Plus 15-9-12, 3-4 month formulation) and two different rates of soluble fertilizer in weekly applications (50 ppm and 200 ppm of 20-10-20 Jack's Professional) on recently propagated modules (40 cm × 30 cm × 10 cm) containing equal proportions of five different *Sedum* species (0.1 g of 3-5 cm cuttings per species) were evaluated.



These species were *album*, *pachyclados*, *reflexum*, *rupestre*, and *tetractinum*. All fertilizer treatments produced fully vegetated modules in six weeks under greenhouse conditions. Species response to the different fertilizer treatments varied, and by the end of the experiment species composition differed dramatically between the fertilizer programs. These findings suggest that there are complex interactions between fertility program and amount of species, and necessitate the need for comprehensive fertility studies with both a single species system and a mixed species system to optimize module production.

### **(324) The Introduction of Ornamental Apple to Beijing**

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Seventy Eight species and cultivars in *Malus* genus were introduced to Beijing. The morphological characteristics, cold of hardiness, drought resistance, waterlogging tolerance and the occurrence and control of pests and diseases were studied. A system for evaluation of ornamental apple cultivar was set up and used in selecting 37 species and cultivars.

### **(325) Performance of 12 Shrub Roses Grown in Northern, Central, and Southern Florida under Low-maintenance Conditions**

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Sales and use of shrub roses have increased dramatically but information on performance in Florida is lacking, especially under low maintenance conditions. Twelve shrub roses were chosen based on availability and reported plant performance in Florida and Texas. Clonally propagated, own root cultivars were obtained as bare root plants or in #1 containers. Six uniform plants of each were installed on 23 Jan. 2008 in southern Florida (Fort Pierce; USDA Cold Hardiness Zone 9b), central Florida (Plant City; USDA Cold Hardiness Zone 9a) and northern Florida (Quincy; USDA Hardiness Cold Zone 8b). Each location followed the same installation and management guidelines. Plants were placed 8.0 ft on center in compost-amended rows covered by a 4.0 ft wide strip of landscape fabric and locally available mulch. Roses were fertilized at planting and every 6 months with a slow release fertilizer (15N-3.9P-10K; 6 month formulation). The initial fertilization rate of 121g N-m<sup>2</sup>, was subsequently increased in central and southern Florida in proportion to their longer growing seasons. Roses were micro-irrigated with 1.9 l-plant<sup>-1</sup> daily for 4 weeks and on alternate days for 8 weeks to establish plants and then weekly thereafter. Plants were pruned at 56 weeks (Feb. 2009) to remove 25% of the plant canopy. Visual quality was assessed monthly on a scale from 0 to 5 where 0=dormant, no foliage present, 3= average, somewhat desirable form and landscape performance, to 5= very desirable form and landscape performance. Monthly flowering was rated from 1 to 5 where 1=no flowers and 5=flowers found on 76-100% of the plant canopy. After 2 years under low maintenance conditions, cultivars with average cumulative visual quality ratings of 3.0 or greater were Knock Out and 'Spice' in southern Florida, 'Mrs. B.R. Cant' in central Florida and Home Run, Knock Out, 'Mrs. B.R. Cant', 'Mutabilis' and 'Spice' in northern Florida. Average cumulative visual quality ratings less than 2.0 were considered unacceptable and were received by 'Old Blush' and 'Perle D'Or' in southern Florida and 'Belinda's Dream', Carefree Beauty, Home Run, 'Old Blush' and 'Perle D'Or' in central Florida. Over the two-year period, Knock Out received the highest average cumulative flowering rating in each location. Other cultivars receiving an average cumulative flowering rating of 2.3 or more were Home Run and 'Spice' in southern Florida and Home Run in northern Florida. Ratings in central Florida were reduced due to damage from chilli thrips (*Scirtothrips dorsalis*).

## Tuesday, August 3, 2010 Springs F & G Sustainable Production 2

### (191) The Effect of Mycorrhizae Products on Nutritional Status of Marigold, *Tagetes patula*

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Marigold (*Tagetes patula*) seedlings were evaluated for their response to two commercially available mycorrhizae products, Mycormax and Mighty Myco. These are two of the numerous products containing a blend of mycorrhizae species available to commercial growers and the general market. Claims for these products suggest that they can increase absorption and translocation of essential plant nutrients including phosphorus, sulfur, calcium, zinc, and copper. The purpose of this research was to discover whether commercially available mycorrhizae products could increase nutrient uptake in a common bedding plant, thus reducing fertilizer requirements. Phosphorus is used to a great extent in the production of bedding plants, and is a major contributor to water quality problems, leading to an overabundance of algae and eutrophication when present in excess amounts. Marigolds were evaluated for germination rate, time to first visible flower bud, time to first open flower, and nutrient status at harvest. Slight differences were seen in germination rate, flower buds, and open flowers. Foliar analysis indicated that marigolds grown with Mycormax had higher levels of nitrogen, phosphorus, potassium, magnesium, calcium, and manganese; slightly higher levels of sulfur, boron, and copper than either Mighty Myco or the control treatment. Mighty Myco had slightly higher levels of zinc than Mycormax, and much higher levels of iron, while the control treatment had far higher levels of iron than either mycorrhizae product. Whereas the increase in phosphorus in the Mycormax treatment was not large (0.33% as compared to 0.25% for Mighty Myco, and 0.27 for the control), nitrogen level differences were more notable (1.66% for Mycormax compared to 1.08% for Mighty Myco and 1.12% for the control). The results of this research indicate that it may be possible to reduce fertilizer use in production of bedding plants, but further studies are required to confirm these results.

### (192) Survey of Sustainability Metrics in the Wisconsin Cranberry Industry

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Sustainable agriculture certainly is not a new concept, but the use of the term “sustainable” as a marketing term is relatively new and popular. As a result, several public and private efforts are underway to quantify sustainability in agriculture. Regardless of market implications, Wisconsin cranberry growers

and associated industries have been working toward reduced economic and environmental risk while playing a critical role in rural communities for many years. Beginning in late 2009, an industry survey was conducted to document steps taken toward the traditional three pillars of sustainability – economic, environmental and social – in Wisconsin cranberry production, as well as to identify knowledge gaps and set a research agenda for future efforts. The survey was sent to 251 growers, and responses were received from over 150 marshes representing 13,200 acres of the 17,700 cranberry acres in Wisconsin. Growers were asked about their practices and marsh structure in 1989, 1999, and 2009. For several of the parameters, two overall observations held true: growers had made great strides over the last 20 years, and the level of compliance with traditional metrics included in several draft or existing sustainability metrics was very high. Ninety-eight percent of Wisconsin cranberry marshes are family owned, and about 70% of marsh employees receive health care and retirement benefits. The average cranberry grower has been in the business for 26 years, and 40% are involved in research efforts on their marsh. For every acre in cranberry production, the grower owns 6.3 acres of non-cropland that serve as wildlife habitat and conserved wetland resources. Professional crop scouts are hired by 77% of growers, and each marsh is scouted an average of 14 times per growing season. Pest thresholds are used to make management decisions by 97% of growers, and 88% use alternatives to pesticides when appropriate to manage pests. Additionally, 95% of growers use recorded weather data in the pest management decision-making process, an increase of 26% over the last 20 years. Soil and cranberry tissue testing are used by 88% of growers to determine fertility inputs, if necessary.

### (193) Nutrient Management Plan for Land Application of Food Processing By-products in Stanislaus County

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Food processing facilities, especially those using raw fruit and vegetable-base materials, generate various types of by-products or non-hazardous wastes. The use of land-applied non-hazardous wastes as an agricultural soil amendment is projected to rise because of public concerns regarding environmental impact and economic constraint of their disposal in landfill or incineration, as well as because of presumed inherent agricultural benefits. We monitored fates of food processing by-product constituents through soil profiles and crop removal, and we tracked movements that may influence soil chemical properties and trace element accumulations in plant tissues. The primary goal of this project was to develop meaningful scientific understanding of food processing by-products characteristics and their effects on soil and groundwater quality, and to develop a best

management practices (BMPs) manual for sustainable reuse of food processing by-products as a soil amendment. Growers often plant forage crops (e.g., alfalfa, Sudan grass, and silage corn) on sites receiving food processing by-products application prior to planting. We monitored fates of food processing by-product constituents through soil profile, crop removal, and their movements that may influence soil chemical properties and trace element accumulations in plant tissues on various field sites with the history of receiving food processing by-products. We will discuss the critical role of establishing nutrient management plan for utilizing food processing by-products as a soil amendment, their fertilizer-replacement-value, and their impacts on the on-farm soil fertility management program.

*Specified Source(s) of Funding:* California State Univ Ag Research Initiative, CDFA-Specialty Crop Grant, Stanislaus County

### **(194) Cover Crops for Use in Reducing Phytophthora Blight Damage to Bell Pepper (*Capsicum annuum*)**

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Cover crops are plants grown to maintain and improve soil quality, reduce inputs to production systems and increase productivity. One particular benefit of growing cover crops is reduced infection of crop plants by soil-borne pathogens. Phytophthora blight is caused by the soil-borne oomycete *Phytophthora capsici*; a pathogen for many commercially grown vegetables within the Solanaceae and Cucurbitaceae families, and some members of the Leguminosae family. Infection occurs when there is excess soil moisture with warm, wet weather and affects plant roots, stems, foliage and fruit; with the latter two being infected when soil splashes onto plants by rain or overhead irrigation, transferring infectious zoospores. Soil between plastic-mulched beds, as are used for fresh-market bell pepper (*Capsicum annuum* L.) production, is normally kept weed-free. This bare ground, often compacted, with poor drainage, can serve as a source for Phytophthora blight infection. Our hypothesis is that a dead or living organic mulch, from cover crops in the inter row alleys, will reduce the incidence of Phytophthora blight in row crops. From initial observations during the first growing season, we saw that having a cover crop growing either side of the bed reduced the number of Phytophthora-damaged pepper fruits, in comparison to both bare soil and straw mulch, and had limited impact on pepper yield. Mowing the cover crop reduced the

number of Phytophthora-infected peppers and increased cover crop biomass yield, compared to not mowing. Of the cover crops grown, Annual ryegrass (*Lolium multiflorum* Lam.) established quicker, yielded the greatest biomass, had the highest percentage groundcover and the lowest incidence of Phytophthora blight-infected pepper fruits, compared to Dutch white clover (*Trifolium repens* L.) and Creeping red fescue [*Festuca rubra* L. ssp. *arenaria* (Osbeck) F. Aresch.].

### **(195) Mechanical Harvesting of California Table Olives**

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Mechanical harvesting must be developed for economically feasible table olive production in California. Olive receiving station grades and values, and trained sensory and consumer panel investigations, have conclusively demonstrated that canopy contact head and trunk shaking harvesters can produce commercially marketable processed table olives. However, thus far these picking technologies have not achieved the necessary eighty percent final harvest efficiency needed for economically feasible production. Attempts to increase the current 64–69 percent efficiency are focused on developing mechanical pruning for the 96 tree per acre traditional orchards and developing new 202 tree per acre hedgerow orchards. Results thus far demonstrate 10 year old hedgerow orchards yield as well as traditional orchards.

*Specified Source(s) of Funding:* California Olive Committee

### (196) Experiments with Biocontrol of *Alternaria alternata*

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A biocontrol yeast (WRL-76) developed by USDA-ARS at the Western Regional Research lab was evaluated for control of *Alternaria alternata* on pistachio. The experiment was conducted over a four year period in a Madera Co., CA orchard. Counts of damaged vs. intact fruit clusters were taken on 100 control and treatment trees, as well as commercial yields. During two of the four years, high levels of disease were observed while little or no disease developed during the other two years. Significant differences in cluster damage were observed during the high disease years. Treated trees produced an overall but non-significant yield improvement of 6.6% for all years and an average 13% yield improvement during the 2 years of high disease incidence. Differences in % viable clusters were significant, however. Cluster count values were significantly correlated with yields.

*Specified Source(s) of Funding:* WSARE

### (197) Biodegradable Mulches for Specialty Crops Produced under Protective Covers

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This SCRI SREP (No. 2009-02484) awarded on 1 Oct 2009 to a team of agricultural, materials, social and textile scientists, is ascertaining whether one experimental spun-bond nonwoven biodegradable mulch (BDM) and two leading commercially-available BDM products (BioBag, BioTelo) are of similar quality to conventional black plastic mulch for high tunnel and open field specialty crop production. A multi-site field experiment in the coastal climate of western WA, high plains of central TX, and subtropical region of TN is underway, with cellulose and non-mulch treatments as reference controls and tomato as the test crop. Three experiments on adaptability of six cultivars each of lettuce, strawberry and tomato to high tunnel production in these contrasting environments have also been initiated. In TN and TX field plantings have been established and in WA plants are ready for transplanting. Field and laboratory protocols for monitoring crop and soil interactions with the BDMs as well as assessing BDM properties, performance and degradation have been refined by team and advisory committee members. Also coordinated or under review for synchronous approaches are field plot designs; cultural practices; crop and harvest assess-

ments; environmental monitoring; soil sampling and analysis; BDM sample receipt, storage and analysis; crop budgets; and, a framework for defining clean technologies. Input from growers in the three regions will be critical to successful adaptation, implementation and long-term feasibility of BDMs. Thus, procedures and criteria for recruitment and selection of potential focus group participants and survey respondents are being developed to understand values, beliefs and attitudes towards BDMs, and the social norms and practices of participating communities. To date, an experimental BDM manufactured in Saxon, Germany for the project and the other four mulch products have been received at all three sites. One postdoctoral associate and four graduate students have been hired. Analytical equipment for the textile laboratory in WA and environmental monitoring instruments and field supplies for WA, TX, and TN have been purchased. Baseline soil samples from TN have been analyzed for bulk density, microbial biomass C, two enzyme potentials related to C and N cycling, and microbial community structure via phospholipid fatty acid profiling (PLFA); baseline data from TX and WA soil samples is commencing. One internal website has been created for information sharing among team members, and one public website (<http://vegetables.wsu.edu/plasticulture.html>) has been dedicated for general outreach. This SCRI team and its advisory committee will meet 24–25 June 2010 in Mount Vernon, WA.

*Specified Source(s) of Funding:* USDA SCRI SREP

## Tuesday, August 3, 2010 Springs F & G Viticulture & Small Fruits 1

### **(250) Evaluation and Demonstration of a Mobile Steam Applicator to Disinfest Soil in Field-grown California Strawberry and Flower Production**

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Steam can effectively kill soil borne pests if soil temperatures can be raised to 70 °C for 20 min. The Ferrari Sterilter is capable of generating super heated steam to reach these temperatures within 5 to 7 min. Frontal plates on the machine allow it to thoroughly heat the soil to 30 cm depth, granting homogeneous

soil disinfestation. In Nov–Dec. 2009, demonstration trials were initiated at a commercial strawberry site at Salinas, CA, and a cut flower nursery site at Carlsbad, CA, to evaluate the Sterilter under field production systems and to demonstrate its operation to the growers. Local growers and few industry representatives were present during treatment application. Soil at both sites was worked with a rototiller after which steam was applied to the soil with the Sterilter for a period of 6 min. At Salinas, total area treated with steam was sufficient for five raised beds that were each 30.5 m long × 1.4 m wide. The neighboring five beds remained untreated. Temperatures during the steaming process were recorded using temperature probes installed at 8-, 15-, and 30-cm depths. Strawberry variety ‘Albion’ was planted on 24 Nov. 2009. Steam treatment did not injure strawberry plants. Weed density counts were taken along the entire length of the bed and initial weed density counts on steam treated plots were 76% lower than untreated control. Strawberry plants in the steam treatment had 4% larger canopy diameters than untreated plots. At Carlsbad, the study was arranged in a completely randomized design. Seven plots 15 m long × 2 m wide were steam treated and five plots remained untreated. Permeable nylon mesh bags containing soil infested with citrus nematode and other free living microorganisms were buried at 15 and 30 cm in the center of the plots prior to treatment, and removed one day after treatment. Beds were seeded with *Ranunculus* on 5 Jan. 2010. At 15 cm depth, the citrus nematode and free living microbial population was significantly reduced in steam treated plots compared to untreated plot at  $\alpha = 0.05$ . At 30 cm depth, only the free living microbial population was reduced in steam plots. Operation costs for the Sterilter in Nov. 2009 were determined to be \$3848 per acre. We will continue to monitor the weed data and will determine crop yield at both locations. Results will be presented to growers and industry representatives at field days in June 2010.

*Specified Source(s) of Funding:* USDA, Cooperative State Research, Education and Extension Service

### **(251) Varying Rates of Preplant Controlled-release Nitrogen (N) and In-season Fertigated N Affect Soil and Plant N and Strawberry Fruit Yield**

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Conventional strawberry (*Fragaria × ananassa* Duch.) N fertilization practices in California have traditionally been based on

a combination of pre-plant controlled release (CR) fertilization banded below the plant row and in-season fertigation. Nitrogen has been detected in surface and ground water in the Santa Maria Valley of California and a conditional pollution waiver requires farmers to carefully manage N. The CR fertilizers are considerably more expensive as a group than other potential N sources and the N application rate is important to lower production costs minimize excess nitrate and where possible. We conducted this trial between Oct. 2008 and Aug. 2009 with 'Albion' strawberry transplants to determine the plant and soil effects of different pre-plant CR N rates and in season N rates and effects on weekly fruit yields. Pre-plant CR rates were 0 (OCR), 74 (74CR), and 154 kg·ha<sup>-1</sup> of N (154CR) as 18N-3.5P-7.8K. Nested within each of these treatments were 2.85, 5.7, and 11 kg N ha<sup>-1</sup> week<sup>-1</sup> as calcium ammonium nitrate (17N-0P-0K) and treatments were replicated 5 times. Weekly injections began 10 Jan. 2009 following transplanting on 14 Nov. 2008. Total seasonal N applied were 88 154 kg·ha<sup>-1</sup> of N in the 0CR-2.85 154 kg·ha<sup>-1</sup> of N per week and up to 422 154 kg·ha<sup>-1</sup> of N in the 154CR -154 kg·ha<sup>-1</sup> of N treatments. Weekly soil nitrate N (SNN) in 154CR plots generally varied from 25–100 ppm in contrast to 0CR plots that generally varied 10–20 ppm. All plots fell below 10 ppm during a rainy period in mid February when three weeks of rain prevented injection treatments and may have leached N below the sampling zone. SNN generally varied directly with the amount of pre-plant CR N applied, but weekly-injected N amounts were not consistently related to SNN. Total plant dry weight and total N uptake was lower for the 0CR than higher CR N rates but was not different between 74CR and 154CR and were not related to weekly N treatment rates. Highest total seasonal fruit yield exceeded 85,500 kg·ha<sup>-1</sup> and was higher in 74CR and 154CR treated plots than 0CR treatments but yields in 74CR and 154CR treatments did not differ significantly. Yields of weekly N application rate plots only differed in the 0CR plots and were directly related to N rates. These results can guide growers on efficient N fertilization for profitable strawberry production that minimizes off-site N movement.

### (252) Growth, Yield, and Ion Relations of Strawberry in Response to Irrigation with Chloride-dominated Waters

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Strawberry is listed as the most salt sensitive fruit crop in comprehensive salt tolerance data bases. Recently, concerns have arisen regarding declining quality of irrigation waters available to coastal strawberry growers in southern and central California. Over time, the waters have become more saline, with increasing proportions of sodium (Na<sup>+</sup>) and chloride (Cl<sup>-</sup>). Due to the extreme Cl<sup>-</sup> sensitivity of strawberry, the rising Cl<sup>-</sup> levels in the waters are of particular importance. In order to establish the

Cl<sup>-</sup> toxicity for strawberry, cultivars 'Ventana' and 'Camarosa' were grown in twenty-four outdoor sand tanks at the ARS-USDA U.S. Salinity Laboratory in Riverside, CA, and irrigated with waters containing a complete nutrient solution plus Cl<sup>-</sup> salts of Ca<sup>2+</sup>, Mg<sup>2+</sup> and Na<sup>+</sup>. The experiment was a randomized block design with two cultivars, six salinity treatments with osmotic potentials (OP) of -0.0251, -0.0350, -0.0450, -0.0521, -0.0604, and -0.0800 MPa (electric conductivities = 0.835, 1.05, 1.28, 1.48, 1.71, and 2.24 dS·m<sup>-1</sup>) and four replications. Fruit, leaf, petiole and root tissues were analyzed for mineral ion content. Marketable fruit yield of Ventana was not significantly reduced from a maximum of 925 g/plant until the osmotic potential of the irrigation waters fell below -0.06 MPa (1.70 dS m<sup>-1</sup>) and solution Cl<sup>-</sup> exceeded 8.2 mM. Camarosa fruit yield under non-saline conditions (770 g/plant) was lower than that of Ventana and yield was not significantly reduced until external OP fell below -0.052 MPa (1.48 dS m<sup>-1</sup>) and solution Cl<sup>-</sup> exceeded 6.1 mM. Both cultivars appeared to possess an effective exclusion mechanism whereby Na<sup>+</sup> was sequestered in the roots and Na<sup>+</sup> transport to leaf, petiole and fruit tissue was limited. Chloride content of the plant organs increased as OP decreased and substrate Cl<sup>-</sup> increased from 0.1 to 13 mM. Chloride content was highest in the roots, followed by the leaves, petioles and fruit. Marginal leaf burn was associated with symptoms of Cl<sup>-</sup> toxicity. The data indicate that strawberry is sensitive to both osmotic and specific ion effects of salinity.

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### (253) Weed Control and Canopy Light Management in Blackberries

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Weed control in blackberries (*Rubus* spp.) is a serious problem for organic producers and those who wish to reduce their reliance on herbicides. At the southern limits of blackberry production, late season yields are reduced because of high day-time temperatures generated by solar irradiation and other environmental constraints. In a field experiment using 'Kiowa' root cuttings established in 2008, weeds were controlled mechanically by hand and with an industrial grade laminated white plastic. In spring 2009, plant volume and leaf area were improved by use of white plastic. Early season flowering on 30 Mar. and the number of red fruits on 27 Apr. were increased by white plastic. After the third harvest on 19 May, half of the weed control plots were tented with 40% shade cloth for the remaining 7 weekly harvests, resulting in improved cumulative yields from both white plastic weed control and shading. Shade reduced ripe fruit temperatures by 3.4 C ( $P=0.0002$ ) regardless of weed control method. The percentage of reflected light through the canopy was improved by white plastic and was not influenced by shading ( $P=0.001$ ). Air movement over the canopy (not replicated) was reduced 30% by shading. White plastic alone improved the cumulative season yield by 86%, while shade alone increased season yield

by 34%. The combined use of white plastic and shade increased season total yield by 142% or 4.4 Mt / ha compared to current production practices (bare ground and no shading). Late season average fruit weight, % SS, and berry juice yield (ml/g) were improved by shade application.

### **(254) Selecting Strawberry Cultivars for Winter Greenhouse Production**

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Costs of transportation and food safety concerns have spawned an increase in public support of locally grown produce and fruit. With this in mind, a two-phase investigation was planned with the goal of incorporating low start up costs for sustainable greenhouse production with selection of strawberry cultivars that would provide the greatest benefit in terms of number and size of berries as well as nutraceutical properties. Twelve strawberry cultivars, some day neutral and some short day responsive, were grown from September through late April. In phase I, all plants were potted in a soil-lite mix in 6-inch pots, watered as needed and grown in a glass greenhouse as part of a student laboratory experience. By mid December, at least one plant per cultivar had flowered and produced fruit. Some cultivars such as 'Sweet Charlie' and 'Albion' were highly prone to spider mite infestation, but still fruited. In phase II, 24 plants of each cultivar were selected based on similar leaf number and uniform plant size. All runners, flowers and fruit were removed and plants were replanted in new soil-lite mix and placed across two benches in a poly-covered greenhouse. The phase II experiment was set up as a randomized complete block design with 6 replications of four plants per cultivar, 3 replications running north-south on each bench. Data taken included: date of first flower, total

fruit number and berry weight per plant. Berries were deemed ripe based on color comparison between berries in the grocery store and those on the bench standardized by using the RHS color chart. Bees (*Bombus impatiens*) were introduced when the first flowers started to open. Within four weeks, some cultivars, e.g. 'Albion' and 'Strawberry Festival', resumed flowering and fruiting. Other cultivars were slower to respond, e.g. 'Darselect', 'Evie-2', 'Honeoye' and 'KRS-10'. This was different than phase I observations with 'Darselect', 'Evie-2', 'Honeoye', 'AC Wendy' and 'Seascape' among the cultivars showing good flowering/fruiting. Mite infestations once again occurred and were curtailed by spot spraying using organic-approved oil. In addition to total yield, nutraceutical properties including total phenols will be presented.

*Specified Source(s) of Funding:* NDA-USDA 2009 Specialty Crop Block Grant Program- Farm Bill (SCBGP-FB)

### **(255) Methods for Altering the Flowering Time in Strawberries**

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The main strawberry (*Fragaria xananassa* Duch.) harvest season in the mid-Atlantic coast region is from May to July. Out-of-season fruit production in the region is low. Producing strawberry transplants from runner tips that were plugged in early July rather than the standard time (early August) promoted fall flowering in short-day cultivars 'Chandler', 'Carmine', 'Strawberry Festival', and 'Sweet Charlie'. Under protected cultivation, July-plugged plants bloomed earlier and produced fruit in October, November and December. This novel technique for propagating strawberry transplants for annual plasticulture combined with production under high tunnels creates an opportunity for strawberry production in early winter and again in the spring (double cropping) in the mid-Atlantic coast region. In another study, growing transplants under photoselective nets in August inhibited flowering in the fall. Flowering in plants that were grown under red- or blue-colored photoselective nets occurred in early January. The results of this study suggested that the photoselective shade net over strawberry plug plants in August affects the light signal needed for flower bud initiation, delaying flower initiation until plants are transplanted in the field. The colored nets did not affect runnering during fall months.

*Specified Source(s) of Funding:* Federal and N. Amer. Strawberry Research Foundation

Tuesday, August 3, 2010

Springs F &amp; G

## Crop Physiology: Growth Regulators

### (094) Effect of Growth Regulators on Florescence of *Rhododendron agastum* Balf. et Smith

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One hundred miles of natural *Rhododendron* (Baili *Rhododendron*) in western Guizhou (China) attracted thousands of visitors during their spring flower season. To extend their flowering duration and bring more visitors to this natural wonder, growth regulators, GA<sub>3</sub>, Ethephon, Daminozide, and 2,4-D, with various concentrations were sprayed on *Rhododendron agastum* Balf. et Smith (charming rhododendron) for one or five times since November. Plants received GA<sub>3</sub> at 200 and 400 mg·L<sup>-1</sup> flowered 10 and 14 days earlier, but no effect on the flowering duration. If sprayed GA<sub>3</sub> for five times, flower initiation were significantly earlier and flower duration was significantly extended. Ethephon did not have significant influence on the blossom. The combined applications of GA<sub>3</sub> and 2,4-D could promote the flowering duration for more than one week. The number of flowers increased as the GA<sub>3</sub> concentration went up and reached 140 flowers per plant at 400 mg/L. GA<sub>3</sub> promoted the growth and elongation of cells. To increase the number of flowers and extend the flowering period, GA<sub>3</sub> could be sprayed five times on the natural communities of *Rhododendron agastum* from November. The applications should improve florescence and better promote Baili *Rhododendron* as one of the popular tour destinations in Guizhou, China.

### (095) Benzyladenine (6-BA) Promotes Branching of Herbaceous Perennials

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Benzyladenine, 6-BA (Configure, Fine Americas, Inc.), was applied as a foliar spray to *Gaillardia aristata* 'Gallo Yellow,' *Gauralindheimeri* 'Siskiyou Pink,' *Geranium* 'Rozanne,' *Penstemon digitalis* 'Husker Red,' *Phlox paniculata* 'Laura,' *Veronica longifolia* 'Icicle,' and four *Echinacea* cultivars, Fragrant Angel, Merlot, Sombrero Hot Pink, and Tiki Torch. Plants were treated with 600 mg/L of 6-BA and compared to a control (using only water). The effects of these spray applications on height, number of branches, and phytotoxicity, were assessed at 0, 2, 4, 6, 8 and 10 weeks after treatment (WAT). The number of basal branches on treated *E.* 'Fragrant Angel,' 'Merlot,' and 'Tiki Torch' increased more than 69% at 4 WAT and beyond. Height was suppressed in treated *E.* 'Fragrant Angel' and *E.* 'Merlot' by more than 10% at 4 WAT. Treated *G. aristata* 'Gallo Yellow' plants had a 164% increase in the number of branches at 8 WAT. Treated *G.* 'Rozanne' plants had a 24% increase in the number of branches at 2 WAT. Treated *G. lindheimeri* 'Siskiyou Pink' plants had a 32% increase in the number of branches at 4 WAT. Treated *P. digitalis* 'Husker Red' plants had a 24% increase in the number of branches at 4 WAT and height was suppressed by 25% at 2 WAT. Treated *V. longifolia* 'Icicle' plants had a 118% increase in the number of branches at 2 WAT, after which this difference diminished. Plants that showed no response to 6-BA in terms of branching or height suppression were *E.* 'Sombrero Hot Pink,' and *P. paniculata* 'Laura.' Minor phytotoxicity was observed on all of the *Echinacea* cultivars and *P. digitalis* 'Husker Red' at 2 WAT but damage was insignificant at 3 WAT.

### (096) Effects of Exogenous Abscisic Acid on Carotenoids and Fruit Quality in 'Micro-Tina' Tomatoes

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Tomatoes (*Lycopersicon esculentum* Mill.) are one of the most widely consumed vegetables. Tomatoes are studied extensively as models for fruit development and ripening research. 'Micro-Tina' tomatoes are a red fruited, dwarf cultivar with a compact growth habit, and may serve as a model crop for physiological and biochemical research. Abscisic acid (ABA) plays regulatory roles in plant growth and development, in seed dormancy, and plant stress. Recent studies have revealed physiological impacts in late stages of fruit development induced by increasing concentrations of ABA. Changes in ABA concentration, along with



increased ethylene activity improve fruit quality by increasing soluble sugars and carotenoids in the developing fruit. Our objective was to study the effects of exogenous ABA on tomato phytonutrients and fruit quality. 'Micro-Tina' tomatoes were grown in nutrient solution and ABA was applied to the solution just before flower initiation at concentrations of 0.0 (control), 0.4, 2.0, 10.0, or 50.0 mg ABA/L. Fruit was harvested, graded and analyzed for mineral nutrients, soluble sugars, and carotenoid pigments. There was no significant change in mineral nutrients with increasing concentrations of ABA. However, there was a significant increase ( $P \geq 0.05$ ) in total soluble sugars. Soluble sugars ranged from 57.03 to 101.28 mg/g dry weight (DW) and responded quadratically to increasing ABA treatments. Fructose also followed a quadratic fit ( $P \geq 0.05$ ) to the data, and ranged from 37.76 to 50.08 mg/g DW. Abscisic acid did not influence concentration of fruit tissue beta-carotene [0.53 mg/100 g fresh weight (gfw)] or lutein (0.37 mg/100 gfw). However, fruit tissue lycopene significantly increased ( $P \geq 0.05$ ) with ABA treatment concentrations, ranging from 9.18 to 14.75 mg/100 gfw. As a result, this study shows exogenous ABA applications can significantly increase fruit quality parameters in tomatoes.

*Specified Source(s) of Funding:* Univ of Tennessee Agriculture Experiment Station

### (097) Chemical Thinning of King Dominant and Non-king Dominant Apples: A New Approach for Assessing Thinner Efficacy

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The efficacy of chemical thinning is often evaluated by means of fruit set or crop load, and little attention is paid to cluster composition, i.e. fruit number per cluster and fruit position on cluster. However, these traits may also play important role in fruit quality. To assess thinner efficacy, net photosynthesis, dark respiration and ethylene production of individual fruitlets in known positions of the cluster of king dominant ('Fuji'/B.9) and non-king dominant apples ('Buckeye Gala'/B.9) were measured after 6-BA, NAA and carbaryl applications at 12 mm fruitlet size. All chemical thinners reduced fruit set, crop load and altered cluster composition in both 'Gala' and 'Fuji' cultivars. None of the chemicals appeared to be selective for king vs. side fruitlets for 'Gala' resulting in a constant share of single, double and multiple fruited clusters in the control and any of the treatments. For 'Fuji', 6-BA and NAA seemed to be more selective than carbaryl and caused primarily side fruitlets to abscise over king fruitlets. NAA applications significantly reduced fruitlet photosynthesis regardless of cultivars and fruit position on the cluster. Clear alteration of fruitlet photosynthesis after 6-BA treatments was not observed; while photosynthesis of 'Gala' fruitlets were not significantly influenced, photosynthesis of 'Fuji' side fruitlets decreased in some positions of the cluster.

Ethylene evolution of treated fruitlets was significantly increased by NAA or 6-BA applications (4 and 7 days after application) but not by carbaryl sprays.

### (098) Effect of Chemical Thinning on Sunburn Incidence of 'Honeycrisp' Apple

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Chemical thinning through crop load has a direct effect on leaf-to-fruit ratio which strongly correlates with fruit exposure to the direct sunlight. Therefore chemical thinning is expected to affect sunburn incidence of fruit as well. In this trial, the incidence of three types of sunburn (sunburn necrosis, sunburn browning and photooxidative sunburn) on 'Honeycrisp'/B.9 was evaluated in various chemical thinning programs. The following spraying programs were applied; spraying at full bloom (liquid lime sulfur + dam oil) or petal fall (6-BA + carbaryl) or post-bloom at 10-12 mm king fruitlet size (6-BA + carbaryl) or at any combinations of above. In the control, 9.1% total sunburn damage was observed, and the most common sunburn type found was sunburn browning (7.3%) followed by sunburn necrosis (1.1%). The symptoms of photooxidative sunburn were found very rarely (0.7%). Chemical thinner applications reduced crop load and increased leaf-to-fruit ratio resulting in lower levels of sunburn damage. The share of the different types of sunburn was changed and the relative ratio of sunburn browning decreased and of sunburn necrosis increased. The share of photooxidative sunburn was not affected by thinner application. Multiple applications of thinners reduced crop load more and resulted in less sunburn damage compared to single chemical applications. Although thinner application altered cluster composition increasing the share of singles and decreasing multiple fruited clusters, strong correlation between fruit number per cluster and sunburn incidence were found. Comparative fruit quality parameters of sunburned fruit are also reported.

Tuesday, August 3, 2010

Springs F & G

## Nursery Crops 2

### (299) Current Mechanization Practices among Greenhouse Operations

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In 2008, the estimated annual economic impact of the Green Industry in the Gulf South amounted to \$5.182 billion, employing 71,978 workers. As horticulture production in the region increases in value, it is expected that pressure for nursery and greenhouse growers to increase production capability and efficiency will rise. A socioeconomic survey of nursery automation was conducted in the Gulf South as part of a research program undertaken by the Mississippi Agricultural and Forestry Experiment Station and the U.S. Department of Labor entitled 'Enhancing Labor Performance in the Green Industry'. The project examined the major tasks performed among greenhouse operations without mechanization/automation. A total of 215 nursery automation surveys were completed through personal interviews with wholesale nurseries (88), greenhouses (52), and mixed nursery and greenhouse operations (75) in Mississippi, Louisiana, Alabama, Florida, Tennessee, South Carolina, North Carolina and Georgia. Only the greenhouse operations and mixed nursery and greenhouse operations were considered for the purposes of this project. The ten nursery tasks included in the survey were media preparation, pot/tray filling, cutting/seed collection, cutting/seed preparation, sticking cuttings/planting seed, environmental control, harvesting and grading production, greenhouse fertilizer application, greenhouse pesticide application, and irrigation management. Little automation was reported for the tasks of harvesting, cutting/seed collection and preparation, sticking cuttings/planting seeds, and media preparation. Pot and tray filling as well as fertilizer and pesticide application were also reported as being done primarily by manual means. Two of the major tasks were performed by workers with substantial mechanization. Environmental control and irrigation management both were indicated by only 39% of growers as having no mechanization in these areas. The mechanization systems used in environmental control included: boilers and heaters, computerized greenhouse controls, fans, and roll-up sides. Irrigation management included mechanization systems such as: drip, misters, injectors, timers, sprinklers, overhead, hoses and nozzles, or some combination of these. These survey results indicate that there is a great deal of room for mechanization implementation among the participating greenhouse and mixed operations, particularly in the areas of harvesting and grading production, cutting/seed collection, cutting/seed preparation, sticking cuttings/planting seed, and media preparation. Results of this analysis will provide guidance for horticulture research scientists to make recommendations as to which automation/mechanization systems could be most beneficial to the growers. In addition, growers can use this information to make more informed financial and personnel decisions.

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### **(300) Pruning Method Influences Growth of Woody Florals**

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Woody floral shrubs are commonly harvested for their colorful stems or flowers. This renewal-type of pruning often gives erratic re-growth which may or may not yield market quality stems. Two experiments, irrigated and non-irrigated were designed to test different pruning and restraint methods to encourage higher quality stem production. Red twig dogwood (*Cornus sericea* cv *Coloradensis*), flame willow (*Salix* x 'Flame') and French pussy willow (*Salix caprea*) were included in each experiments. The experiments were conducted as randomized complete block design with at least 3 blocks for each species in each experiment. Blocking criterion was spatial proximity. One plant was the experimental unit, and treatments were randomized to all experimental units within a block. Treatments were: Control (C) - harvest pruning only. Restraint and peripheral pruning (R) - harvest plus a 24" tall section of black plastic pipe 30" in diameter was placed over/around each plant and stems that touched or protruded beyond the restraint were pruned away. The restraint was left in place throughout the growing season. Peripheral pruning (P) - same as R except the restraint was removed following pruning. Peripheral and interior pruning (I) - same as P plus stems were also pruned back and dead wood removed from an area about 9" by 5" in the center of the plant. Data collected included total number of stems per bundle, number of stems with physical damage or poor color, field height of tallest stem, and field weight of harvested bundle. Market quality stems were measured for length, diameter and number of branches plus number, location and stage of catkin development (pussy willow only). Statistical analyses were conducted using a mixed models analysis of variance (ANOVA) implemented using SAS PROC GLIMMIX. Significant differences among treatments were identified through the use of pair-wise comparisons. The height of pruned pussy willow, flame willow and red twig dogwood stems were not different from the control in either experiment. However, for specific variables, individual plant by treatment interactions occurred. For example, interior pruning of pussy willow yielded longer saleable quality stems. Field weight and number of stems were affected with the restraint treatment producing fewer stems, but often more of saleable quality. For flame willow, distance to the first branch was longer for the restraint treatment which may be a market advantage. Given the hundreds of stems harvested, the number of market quality stems was much lower than anticipated.

*Specified Source(s) of Funding:* USDA-CSREES Tribal Colleges Research Grants Program

### (301) Growth of Containerized *Acer saccharinum* from Seed in a Cedar-amended Substrate

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Due to increasing scarcity and cost of pine bark, compounded in regions that lack indigenous pine species, alternative substrates for containerized nursery production are being sought. Utilization of eastern redcedar (*Juniperus virginiana* L.) as a substrate component could alleviate pine bark demand in these regions with a sustainable, local resource. Previous work has demonstrated that eastern redcedar may be an acceptable substrate component for some woody species. The purpose of this study was to evaluate the use of eastern redcedar as a potting substrate component for nursery crops propagated from seed. This study evaluated the growth of silver maple (*Acer saccharinum* L.) from seed in substrates composed of 0, 5, 10, 20, or 80% eastern redcedar chips that passed a 19 mm hammer-mill screen, 20% sand, with the remaining volume composed of pine bark, and two treatment rates of controlled release fertilizer (low = 4.5 kg·m<sup>-3</sup>, high = 8.9 kg·m<sup>-3</sup>). Plant height was not significantly affected by fertilizer rate during the study. At 48 days after planting, plant height averaged 23.1 cm except 80% cedar which averaged 12.0 cm. At 76 days after planting height varied among substrates, however plants grown in 80% cedar grew the least at 12.9 cm. Fertilizer had a significant affect on root and shoot dry weight as well as tree caliper with plants grown in the high fertilizer treatment having more growth than plants growing in low fertilizer treatment. Both fertilizer rates showed similar trends within the substrate treatments. Substrates containing 0% to 20% cedar produced plants similar in caliper, root dry weight, and shoot dry weight. Plants grown in 40% cedar substrates generally had less caliper, root dry weight, and shoot dry weight than plants grown in substrates containing 0% to 20% cedar, while plants grown in 80% cedar had significantly less growth than all other treatments. The lack of growth in 80% cedar substrates may result from physical properties (high air space, low container capacity) due to substrate processing through the 19 mm hammer-mill screen rather than an allelopathic or otherwise toxic quality of cedar. These results suggest that eastern redcedar could be a replacement for pine bark as a substrate in container-grown nursery operations with further development of substrate physical properties.

*Specified Source(s) of Funding:* USDA-ARS Floriculture and Nursery Research Initiative

### (302) Technology for Improved Tree Liner Production in Ontario, Canada

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As natural forest ecosystems are declining, more emphasis is being placed on the urban forest for tree-given benefits such as carbon sequestration, fine-particle filtering and noxious compound removal. Trees maximize their utility after 30 years of age, however in the urban environment the average life span for a tree is 10 years therefore increasing survival of trees through improved stock is necessary for maintaining the urban forest. Eleven different species from 8 genera (*Acer*, *Betula*, *Celtis*, *Cercis*, *Gleditsia*, *Quercus*, *Robinia* and *Syringa*) were planted in spring of 2009 at the Vineland Research and Innovation Centre in a retractable roof greenhouse (RRG), which was programmed to open between the temperatures of 10° and 26.6° C. GeoHumus (GeoHumus International GmbH & Co. KG, Frankfurt, Germany) a substance that retains water and degrades over 3-5 years was added to the substrate in 0, ½, 1, and 2% additions by volume. Additionally, *Betula* X 'White Satin', *Syringa*, *Acer freemannii* 'Firefall', and *Robinia* were chosen for a transplant study and were planted directly into a #3 container or were put in air-pruning Elle pots (A.M.A. Plastics, Kingsville, ON) grown for one month then transplanted into #3 containers. All the remaining species were planted into #3 containers and grown for 20 weeks. Three randomly selected plants per species per production environment were monitored. In September caliper, height, and leaf areas using Model Li-3100 leaf area meter (Li-Cor Inc., Lincoln, NE) were taken. One randomly selected tree per rep and species was selected for leaf area and dry weight measurements. Generally the 2% GeoHumus addition yielded plants with a greater caliper, but this trend was not consistent in all the species. Air pruning Elle pots improved growth in *Betula* and *Robinia*, but *Acer* was best grown in a #3 pot.

### (303) Fabric Containers Enhance Survival of Selected Over-wintered Nursery Stock

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Field observations prior to 2004 indicated that nursery stock growing in fabric above-ground containers may have higher survival rates than that growing in plastic containers, when exposed to cold events. During the winter of 2004-05, four species of shrubs were left in the container nursery without winter protection in Durham NH (zone 5b) and differences in survival and spring growth due to container type were confirmed. Since then, ten species representing a range of cold hardiness ratings have been screened in multi-year trials for survival and growth responses associated with container type. Plants over-wintered *in situ* were compared to controls over-wintered in traditional covered piles. *Physocarpus opulifolius*, *Potentilla fruticosa*, *Potentilla parvifolia*, and *Stephanandra incisa* survived and grew normally regardless of container type or treatment. *Itea virginica* and *Ilex x meserveae* were completely winter-killed in both exposed container types, surviving only in protected piles.

Fabric containers resulted in reduced mortality rates for four species (*Viburnum plicatum tomentosum*, *Viburnum trilobum*, *Weigela florida*, *Cornus sericea*), compared with plastic containers in situ. These plants represent zone 2 - 5 hardiness ratings, indicating lack of correlation between root cold tolerance and shoot hardiness. Although there was no difference in mean root zone temperatures during the coldest months of 2007–09, minimum temperatures averaged 4 °C lower in exposed plastic than in fabric containers.

*Specified Source(s) of Funding:* N.H. Agricultural Experiment Station

### **(304) The Influence of Storage Time and Lime and Peatmoss Amendments on Pine Tree Substrate pH**

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This study was conducted to determine how pine tree substrate (PTS) pH was affected by storage time and lime and peatmoss amendments. PTS was manufactured (April 2009) from freshly harvested loblolly pine trees (*Pinus taeda* L.), chipped, and hammermilled to two sizes, 4.76 mm, and 15.88 mm; the former substrate was unamended and the latter substrate was amended with 25% peatmoss (v/v, PTSP). The PTS and PTSP substrates were amended with dolomitic limestone at rates of 0, 1, 2, 4, or 6 kg·m<sup>-3</sup>. Substrates were placed in 0.08 m<sup>3</sup> perforated plastic storage bags and stored on shelves in an open shed in Blacksburg, Virginia. Substrates were subsampled at 0, 42, 84, 168 and 270 days. For all days and all lime rates, PTS had higher pH values than the corresponding PTSP treatments due to the acidifying effect of peatmoss. For each sampling time, PTS pH values increased with increasing lime rate, with the largest increases occurring between 0 and 1 kg·m<sup>-3</sup> lime addition. For PTSP, there were relatively large pH increases with the incremental additions of lime, except between 4 and 6 kg·m<sup>-3</sup>. PTS pH values for the first sampling date ranged from 5.8 to 6.6 (for 0 to 6 kg·m<sup>-3</sup> lime) and for PTSP from 5.2 to 6.6 (for 0 to 6 kg·m<sup>-3</sup> lime). From the first sampling day to day 42, pH values decreased in all lime and substrate treatments. However, by day 84, pH values for all treatments with lime addition had increased to values equal to or higher than those found at the first sampling date. pH values for all treatments remained relatively constant from day 84 to day 168. By day 270, pH values of all limed PTS treatments were similar to first sampling values, while the pH of unlimed PTS decreased from 5.8 to 5.0. pH values for PTSP over 270 days were lower than the first sampling date, except for the 6 kg·m<sup>-3</sup> lime rate treatment. After 270 days, PTSP pH for the unlimed treatment decreased 1.2 units, whereas the decrease for the 4 kg

treatment was 0.2 units. Results of this study show that a lime rate of 1 kg·m<sup>-3</sup> is sufficient to maintain PTS pH at or above 5.8 under storage conditions for at least 270 days. A lime rate of 4 to 6 kg·m<sup>-3</sup> is needed to maintain a pH value of 5.8 or higher for PTS amended with peatmoss.

*Specified Source(s) of Funding:* Departmental Fund

### **(305) Growth of Four Native Plant Species in Potting Mixes Amended with Anaerobically Digested Cattle Manure**

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Anaerobically digested cattle manure is a by-product of cattle waste processing for pollution control and biogas production, yet this material has the potential to be an economical component in potting mixes used for sustainable container production in nurseries. The objective of this study was to determine the effects of anaerobically digested cattle manure on the growth of four native plants species grown in potting mixes amended with this nutrient rich material. Five potting mixes containing 0%, 15%, 30%, 45% or 60% composted manure (by volume), 10% sand, and 90%, 75%, 60%, 45%, and 30% aged pine bark, respectively, were used in this study. Anaerobically digested manure was composted for 3 months before it was used in the potting mixes. The native perennials *Mimulus guttatus*, *Holodiscus discolor*, *Philadelphus lewisii*, and *Penstemon strictus* were grown in 3-liter containers of these mixes for four months. Plant heights were measured every three weeks. At the end of the experiment, plant shoots were harvested for biomass determinations. At the beginning of the experiment, some leaves on *Holodiscus* and *Philadelphus* plants grown in 30% or more manure-amended media became chlorotic, and leaf margins became necrotic on some *Holodiscus* plants in the 60% manure medium. Three *Holodiscus* plants with these symptoms died during the study. All four species grew as well or better in media amended with up to 30% manure compared to plants grown in the bark and sand (control) mix. By the end of the study, *Penstemon* plants grown in 60% digested manure grew 17% taller and produced 62% more shoot biomass than plants in the control mix. *Mimulus* plants grown in 30% manure produce about 47% more shoot biomass than control plants, whereas *Holodiscus* plants grown in 60% manure produce at least 18% more shoot biomass than control plants. Shoot biomass production by *Philadelphus* plants was unaffected by the potting mixes. Final shoot heights for *Mimulus*, *Holodiscus*, and *Philadelphus* plants were similar for all plants in all of the potting mixes. This study demonstrated that anaerobically digested cattle manure can be a stable amendment for potting mixes and can improve a bark-based medium when incorporated as 30% of the potting mix volume.

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**(306) Comparison of Fertilizers using Advanced Granule Technology with Industry Standards**

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Commercially available slow/controlled released fertilizers are increasingly becoming more expensive, and any product that can be cheaper yet effective would be advantageous for the nursery grower. A new type of fertilizer being developed, using advanced granule technology (AGT) could be one such product. However, the nursery industry uses different formulations based on targeted crop species and time of fertilizer application. The objective of this study was to assess different AGT formulations for performance on selected nursery crops in comparison to industry standards at two application timings. Three types of formulations were selected, a 3-4 month, 5-6 month, and 8-9 month, with two application timings, one application starting in the fall, and the other starting in the spring. Fertilizers consisted of 3-, 6- and 9-month formulations of 15-9-12 (15-4-10 actual) Osmocote Plus, 3 month formulation of Harrells 16-6-13 (16-2.6-10.8 actual), 6 month formulation of Harrells 16-6-11 (16-2.6-9.1 actual), 9 month formulation of Harrells 15-6-12 (15-2.6-10 actual), AGT 15-9-12 (15-4-10 actual) 3 month formulation, AGT 15-9-12 (15-4-10 actual) 5 month formulation, and two, 9 month formulations of 15-9-12 (15-4-10 actual), one with monoammonium phosphate (MAP), and the other with triple phosphate [or super phosphate(SP)]. The 3 month formulations and triple phosphate formulations were not used in the fall trials. Test locations included two in Ohio and two in Ontario, Canada. The locations in Ohio were at Klyn Nursery in Perry, Ohio, and Decker's Nursery in Groveport, Ohio. The locations in Ontario were at Willowbrook Nursery in Fenwick, Ontario, and J.C. Bakker Nursery (spring start only at Bakker Nursery) in St. Catharines, Ontario. Species selected for testing consisted of *Juniperus scapularum* 'Wichita Blue', *Buxus x* 'Green Velvet', and *Spirea xbumalda* 'Goldmound' from Willowbrook Nursery, *Potentilla fruticosa*, *Juniperus chinensis*, and *Thuja occidentalis* from J.C. Bakker Nursery, *Fothergilla gardenia*, *Ilex glabra* 'Shamrock', and *Juniperus horizontalis* 'Wiltoni' from Klyn Nursery, *Buxus x* 'Winter Gem', *Spirea xbumalda* 'Goldflame', and *Microbiota decussata* from Decker's Nursery. None of the fertilizers provided superior growth at all of the nurseries averaged over species, but some fertilizers' performance was based on the species tested. From these studies, it can be concluded that the AGT 9 month super phosphate formulation does provide detrimental effects to some species, especially when incorporated. The other AGT formulations, in most cases, do seem to perform better when topdressed and applied in spring as opposed to fall application and provide similar growth when compared to the industry standards.

Tuesday, August 3, 2010

Springs F &amp; G

**Organic Horticulture: Cross-Commodity****(231) Plant By-products as Organic Mulchings to Improve Yield and Quality of Watermelon (*Citrullus lanatus* Schard.) in the Mexican Dry Tropic**

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Watermelon is one of the most important socioeconomic horticultural crops in Mexico. Watermelon is the third most important horticultural species for exportation since the 1950s. Mulching is a habitual agronomic practice recently adopted by produce growers to reduce the weeds, pests, diseases and to maintain soil moisture, and this alternative increased the yield and reduced the time for harvesting fresh fruits. However, mulching is not a cheap technology that increased the cost production, and an associated environmental problem has been addressed, the soil contamination with plastic wastes, or air pollution when they are burn. The organic mulching is an environmental compatible technology. The objective was to evaluate the effect of different organic mulches on the yield and quality of fresh fruit of watermelon CV. Liberty under dry tropic conditions in western Mexico. The organic mulches evaluated were banana leaves (BL), sawdust (SD), rice straw (RS), coconut fiber dust (CFD), *Andropogon gayanus* grass (AG), and *Dolichos (Lolicos lablab)* living manure (LM). The treatments were arranged in a completed randomized blocks design with four replications. Data were analyzed using ANOVA and means separated by Tukey test ( $P = 0.05$ ). Results showed no significant differences for the following variables: length guide shoot, number and weight of fruits per plant. The most significant organic mulches were: BL with 4.16 m length guide shoot, CFD with 14.3 fruits per plant, and AG with 7.7 Kg fresh fruit weight. AG produced also bigger dimensions in

equatorial perimeter, and fruit length with 43.2 cm and 62.7 cm, respectively. No significant differences were also determined for yield per hectare, and sugar content ( $^{\circ}$ Brix), but the higher yield was obtained with the AG with 20.6 ton/ha and 8.3  $^{\circ}$ Brix. In conclusion, the organic mulches did not significantly affect the agronomic performance of watermelon under dry conditions. Organic mulching is an important alternative to the use of plastic mulching, and a feasible alternative to use of biodegradable resources in organic mulching horticultural practices.

*Specified Source(s) of Funding:* Universidad de Colima

### **(232) Response of Sweetpotato to an Organic Fish Protein-based Organic Fertilizer and Composted Broiler Litter**

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Field experiments were conducted in 2008 and 2009 to evaluate the influence of an organic fish protein based fertilizer and broiler litter on storage root yield and leaf N elemental concentration of 3 sweetpotato cultivars. Treatments were fish protein-based organic fertilizer (FPP), composted broiler litter (BL), and NPK. Broiler litter was applied at the rate of 134 kg/ha and N P K based at the rate of 134, 67 and 67 kg/ha, respectively, based on soil test. The FPP was applied following manufacturer's recommendation of 30 g/L weekly. Pre-rooted stem cuttings of 'Whatley/Loretan', NCC-58, and J6/66 were transplanted to the field and grown for 120 days. Leaf samples were collected at 4 and 8 weeks after planting and composited, for elemental analysis. Total root and US#1 yield for 'Whatley/Loretan' were higher for plants receiving fertilizer followed by FPP and BL, that for NCC-58 and J6/66 were higher with FPP, BL and fertilizer, respectively. Leaf N exceeded 3.2 % for all treatments except that for BL which was marginally lower. These results suggest that sweetpotato response to FPP was cultivar dependent and that FPP could be a suitable source of nutrients for sweetpotato production in an organic production system.

*Specified Source(s) of Funding:* USDA/CSREES Evans-Allen

### **(233) Health-promoting Phytochemicals in Organically Grown Pac-Choi and Tomato with Different Fertility Levels in Open Field and High Tunnels**

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The effect of contrasting growing and management conditions and fertility levels on the health-promoting qualities of pac-choi (*Brassica rapa* L. 'Mei Qing') and tomato (*Solanum lycopersicum* L. 'Bush Celebrity') was studied in a 2-year field trial. Crops were grown under organic and conventional production practices in high tunnel and open field at various levels of fertility. In both pac-choi and tomato, crops grown in open field had higher total phenolic content and antioxidant capacity than their counterparts grown in high tunnel. However, spring pac-choi appeared to be more responsive to open field environment than the fall crop. In both spring and fall pac-choi crops, the levels of chlorogenic acid and caffeic acid were significantly higher in crops grown in open field than those grown in high tunnel under both organic and conventional environments. Similar results with regard to chlorogenic acid and p-coumaric acid were observed in ripened tomato fruits. However, more striking response was in rutin content in tomato fruits in that fruits from open-field had nearly twice the amount of rutin as those from the high tunnel. The response of phytochemical accumulation in open field appears to be related to the increased light that these plants receive relative to those in tunnels. However, the biomass accumulation and the yield were significantly lower in crops grown in open field than in high tunnels. With regard to the comparison between organic and conventional, the response of total phenolic content and individual phenolic compounds in both pac-choi and tomato was variable and a clear trend was not observed. With regard to fertility, control plants receiving no fertilization under conventional management produced higher content of both total phenolics and of several individual phenolic compounds in both pac-choi and tomato. Thus, increasing fertility tended to decrease the phenolic content. For example, the rutin content in tomato fruits decreased sharply with increasing fertility and the highest levels were found in control plots receiving no fertilization under conventional management practices. However, the results with organic management did not follow a similar trend, perhaps due to the residual and slow release of nutrients from the organic sources in these plots. The results show that producing pac-choi and tomato crops in open-field (high light) with low fertility (nitrogen) significantly enhances their quality with regard to the health-promoting phytochemicals.

*Specified Source(s) of Funding:* USDA-IOP

### **(234) Tomato and Tomatillo Field Trials in an Organic Transitioning Site on the Delmarva Peninsula**

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Organic food sales and consumers' demand for organic food have been increasing rapidly in recent years due to environmental and health concerns of consumers. On the Delmarva Peninsula (Delaware, Maryland and Virginia), limited quantities of organic produce can be found in the produce section of grocery stores, farmer markets and other sales outlets. Organic crop production in this region is low because few growers have organically certified farms. This study was conducted to initiate the transition of a 2-acre conventional Univ farm site to an organic production site, which will serve as an organic research and demonstration location to provide information and encourage local farmers to transition to organic production. A field trial of tomatoes, (*Lycopersicon esculentum*) and tomatillos, (*Physalis philadelphica*) was conducted in the summer of 2009 where six tomato cultivars (Beefsteak, Cherokee Purple, Cherry Sweetie, Debarao Plum, Roma and Tomato Mater Sandwich) and two tomatillo cultivars (Green Tomatillo and Purple Tomatillo) were planted in a complete randomized experiment with four replications for each treatment. Data were collected on yield characteristics and pest injury. Tomato cultivars differed significantly in their marketable fruit yield. Cherry Sweetie tomato and the two tomatillo cultivars produced the highest percentage (60% or more) of marketable Grade 1 yield. Pest damage to plants and fruits was less than 20%. This study indicates that more research is needed to improve the percentage of Grade 1 marketable fruits of these tomato and tomatillo cultivars.

*Specified Source(s) of Funding:* Evans Allen

### **(235) Productive Behavior of Sabila Crop (*Aloe vera barbadensis*) with Bovine Manure Application**

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The agricultural area of Caborca, Sonora in the Sonoran Desert

is characterized by the water shortage, and grounds with majority sandy soil and with little or null organic matter content, reason why they retain little humidity. The Sabila (*Aloe*) plant is considered a strategist crop for the arid and semi-arid lands from Mexico country, because it can be a high water efficiency crop, due to it has low water requirements, and at the moment this are developing satisfactorily although on experimental scale in this area, in the other hand, in this area, cattle as much for meat as for milk, is an important activity, derivate of which, great volumes of bovine manure take place, and those require to disperse or finally becoming a contamination problem. On the INIFAP research center in Caborca, Sonora, in an aloe plantation established during summer of 2002, with a plant density of 15,000 plant.ha<sup>-1</sup> in which, by several years was evaluated the bovine manure effects on soil and aloe plant, a new application was made on may 2006 (20 t.ha<sup>-1</sup>), to evaluate its effect on productive behavior. On December, 2006, we harvest the mature leaf of plant, and we count the leaf number, measure the leaf weight, and the yield of aloe leaf. The results indicate an increase in both, number (7.4 %) and weight (14.1 %) of leaf, for a yield increase of 21.5 %, due to bovine manure effect. At this harvest, the plots with bovine manure produced 129467 leaf. ha<sup>-1</sup>, those weight 594 gr.leaf<sup>-1</sup> for a yield of 76.5 t.ha<sup>-1</sup>

*Specified Source(s) of Funding:* INIFAP-PRODUCE

### **(236) Effects of Organic Rooting Treatments on *Vaccinium darrowii* 'Native Blue' Blueberry Cuttings**

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*Vaccinium darrowii* 'Native Blue' is a low growing compact evergreen shrub with foliage color from light pink to dark green. This cultivar reaches three feet at maturity, produces small semi-sweet fruit, and can be propagated by seed or cuttings. Today many organic rooting treatments are being utilized. Many reports claim honey and Salix solutions decrease rooting time. The objective of this experiment was to compare organic and inorganic rooting treatments to determine which treatment promotes root growth from tip cuttings for 'Native Blue' blueberries. On July 17, 2009 'Native Blue' tip cuttings were taken from Mill Creek Blueberry Germplasm Plots in Nacogdoches County, Texas. Tip cuttings were treated by a quick 30 second dip in one of twelve rooting treatments. The treatments included an untreated control, 2 boiled honey solutions (1 and 2 tablespoon of honey: 473 ml of water), 8 Salix solutions (20 and 40 grams of Salix leaves: 0.95 L water boiled or puréed; 20 and 40 grams of Salix stems: 0.95 L of water boiled or puréed),

and Hormodin® 2 (IBA 0.3%). Treatments were arranged in a randomized complete block design. Tip cuttings were stuck in 1:1 pine bark/perlite substrate ratio. The trays were placed in a mist chamber. Tip cuttings were visually checked at 14, 21, 28, 35, 42, 49, 56, and 84 days after treatment (DAT) to determine differences in root development and rooting time. In visual checks 14 to 49 DAT, 16 of 48 tip cuttings were checked. In each visual check in 56 and 84 DAT all 48 tip cuttings were checked. The data was analyzed by Repeated Measures ANOVA with Binary Response with a minimum significance level of 0.05%. When comparing all treatments and times over the 84 DAT period, treatment type did not significantly affect rooting percentages, and all treatments, including the control, indicated rooting percentages above 81%. When considering only 35 and 42 DAT, the data indicated that the rooting percentage for the Salix treatment (40 grams of Salix stems: 0.95 L of water boiled) was significantly greater than the control and Hormodin® 2.

### **(237) Soil and Plant Nitrogen and Organic Strawberry Fruit Yield Associated with Varying Rates of Nitrogen (N) Applied as Different Certified Organic N Sources**

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Fertilization is one of the most challenging cultural practices for organic strawberry growers in California. Nitrogen (N) is the most important and costly nutrient to manage and cost-effective N management information is needed for efficient organic strawberry production. Nitrogen management can be especially challenging on low organic matter soils that typify some California strawberry growing areas. Compost and green manure cover crops are widely used as economical sources of N for organic vegetable production but long turn around period between organic amendment pre-plant application and N need by strawberry transplants often limits the usefulness of these amendments for organic strawberry growers. Strawberries establish and grow slowly during the early season and growers are forced to depend upon in-season fertigation injection of liquid N sources for much of N nutrient needs. N availability from liquid N sources is variable and N availability may not adequately match crop need for N. Efficient utilization of these materials requires additional data on field performance. We conducted this trial between Oct. 2008 and Aug. 2009 to determine the plant and soil N effects, plant growth, plant N uptake, and fruit yield of

plots receiving varying rates of three organic liquid N sources. We compared True Organic (4N-1.8P-1.2K), Neptune's Harvest (4N-0.9P-0.6K), and Phytamin 434 (4N-1.35P-2.4K) certified organic fertilizers at rates of 6.8, 13.6, or 20.4 kg N ha<sup>-1</sup> per week injected into the fertigation system. Total seasonal N applied varied from 177 to 533 kg N ha<sup>-1</sup>. Weekly residual soil nitrate N (SNN) varied between 0 and 15 ppm from early January to early Apr. 2009 and was unrelated to material or amount of N injected. In early April, weekly SNN increased markedly and weekly SNN from early April to the end of the season ranged from 20 to 35 ppm. Differences in weekly SNN between types of material were not significant but the Phytamin materials were associated with highest SNN most weeks. Total season plant N uptake ranged from 53 to 64 kg N ha<sup>-1</sup> and was not consistently related to N rate or fertilizer material. Total yield ranged from 33,750 to 44,332 kg·ha<sup>-1</sup>. Variability in soil N availability from organic N sources appears to severely limit N uptake, plant growth, and yield. Leaching of N from rainfall and irrigation may play a role in limiting organic strawberry production with marginal N availability from uncertain N sources.

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### **(238) Use of Organic Fertilizer as an Alternative for Sandy Soil Amelioration**

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The effect of agricultural activities on degradation of natural resources (soil erosion, agrochemical use, etc.) is evident in several regions of the country and should be avoided or at least mitigated. The use of biological inoculants (biofertilizers), incorporation of organic amendments, and other agricultural practices such as crop rotation and use of leguminous cover crops, may, in the long term, contribute to the recovery of the soil microbial populations and thereby improve the quality of this resource. An



important option to counter such problems is the use of organic fertilizers to provide nutrients to the soil gradually and also improve their physical, chemical and biochemical characteristics that contribute to increase crop production. The objectives of this work were to study the effect of applying three organic fertilizers on physical-chemical properties of sandy soil, also, evaluate the effect of organic fertilizers on the development and production of chili. The experiment was conducted in the Experimental School of Biological and Agricultural Sciences, Univ of Colima, in Mexico, under field conditions. Organic fertilizers used were Vermicompost, Bocashi, and Cachaza (waste of the sugar cane industry). Doses applied to each product were 5 tons/Ha. Crop growing in all treatments was chili plants (*Cucumis annuum*). Black plastic mulching was used. Variables measured in soil were: pH, electrical conductivity, soluble anions and cations. Data were analyzed using a lineal regression and square model. Also, height plant was measured. Results showed that in Bocashi and Cahchaza (waste of sugar cane industry) treatments, plants grown more than in any other. Electrical Conductivity and pH were increased, respecting to control. Soluble anions and cations, also were increased. In the regression analysis shows, where X represent the height chili plant and is the weight of chili plant, The regression equation  $y = -70.82 + 4.22x$ , and  $r^2 = 0.45$ , variable is highly significant ( $p > 0.001$ ). Using the quadratic model, regression equation is  $y = -56.9 + 3.34x + 0.013x^2$ . Regression analysis for this equation was statistically significant for the regression and the linear term explains the relationship between variables y and x. We consider that, is necessary to study should be done for a longer time, to obtain data more consistent.

*Specified Source(s) of Funding:* Universidad de Colima

### **(239) Variation of Meyer Lemon Bioactives Grown under Organic versus Conventional Cultivation Practices**

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In recent years, organic citrus cultivation has increased to significant proportions worldwide. Research in our lab and elsewhere has shown that citrus bioactives have antioxidant, and anti-proliferative properties. Clinical trials have demonstrated prevention of cardiovascular disease by intake of citrus flavonoids. Meyer lemons (*Citrus meyeri* Y. Tan.) grown under similar climatic conditions by organic and conventional management practices in South Texas were harvested and stored at 8-10° C for simulating the storage marketing conditions. Fruits were processed and evaluated for flavonoids, amines, and organic acids using high performance liquid chromatography by C<sub>18</sub>

column. Total phenolics were determined by Folin Ciocalteu method and expressed as catechin equivalents. Our results indicate that organically grown lemons contain significantly high content of hesperidin, didymin and ascorbic acid than those cultivated under conventional management practices. Total phenolic content was higher but not significantly different in organic lemons compared to conventionally grown. Results suggest that organically grown Meyer lemons are an ideal source for enhanced levels of flavonoids and ascorbic acid. To the best of our knowledge, the concentration of bioactive components in organically grown Meyer lemons is reported for the first time. The present research report is based on work supported by the “Designing Foods for Health” through USDA CSREES Grant # 2009-34402-19831.

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### **(240) Effect of Vermicompost Tea on the Suppression of Root Knot Nematode (*Melodogyne incognita*)**

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Multiple studies have reported the effect of vermicompost in reducing plant fungal and bacterial diseases and nematode infestation in the soil. However, relatively less work has been done to investigate the effect of vermicompost tea (VCT) on the suppression of plant diseases. In this study, experiments were conducted to determine the ability of VCT to suppress nematodes in tomato plants grown in a greenhouse. In addition, the VCT is being further analyzed for fungal and bacterial diversity that might be present in the tea and contributing to the suppression of nematodes in the soil, using USER cloning technique and ribosomal intergenic space analysis (RISA) respectively. Data from ongoing microbiology experiments will also be presented.

*Specified Source(s) of Funding:* Univ of California Experiment Station

### **(241) Evaluation of Phenotypic Characteristics of Sixteen Accessions of Sunn Hemp in Florida**

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Limited adoption of sunn hemp (*Crotalaria juncea*) as a cover crop in the U.S. is primarily due to the irregular supply and high cost of imported seed. Seed production in the continental United States would provide a more consistent supply of lower cost seed while also providing growers with a new seed crop. Improved availability and affordability of sunn hemp might encourage its utilization by growers in their cropping systems for weed and pest suppression, soil stability, and nitrogen and biomass accumulation. Sixteen accessions of sunn hemp were evaluated in 2008 and 2009 at Rosie's Organic Farm in Gainesville, Florida to assess their vegetative and reproductive characteristics and potential for seed production in Florida. The experimental design was a split plot with planting dates (May, June, and July) assigned to the main plots, which were arranged in a randomized complete block design with four replications. The sixteen accessions were randomly assigned to the sub-plots. Data were collected on plant height, leaf area, number of leaves, number of branches, plant weights, days to first open flower, and seed production. Field observations suggested that accessions could be separated into two distinct groups based on size and daylength sensitivity. Analysis of the vegetative and reproductive data provided evidence for one group of short-day accessions and one group of day-neutral accessions. The short-day accessions were taller, with higher shoot biomass, later branching and flowering than the day-neutral accessions, and little or no seed. The day-neutral accessions flowered early and produced viable seed in summer. Of these accessions, PI 314239 and PI 322377 produced the most seed, demonstrating potential for use for seed production in Florida. These accessions had the lowest shoot biomass, making them less desirable as a cover crop. Future work will focus on developing day-neutral cultivars of sunn hemp that retain the cover crop attributes of the commercially available short-day sunn hemp varieties, but are capable of producing seed in Florida.

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Springs F & G

## Postharvest 2

### (107) Expression of Ripening-related Genes as Affected by Chilling in Tomato

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The effects of chilling on the expression of ripening-related genes has been studied in a tomato (*Solanum lycopersicum* S. pennelli) introgression line (IL 11-2). Tomato fruit were harvested at breaker stage of maturity and ripened at 20 °C for 0 to 14 d, or stored at 3 °C for up to 4 weeks, and then ripened at 20 °C. Climacteric ethylene production was increased in fruit stored for 1 week, but reduced in fruit stored for 4 weeks. Fruit ripening was delayed or inhibited in fruit stored for 2 and 4 weeks as assessed by red color development and softening at 20 °C. The expression of genes involved in color development, phytoene synthase1 (*PSY1*), carotenoid isomerase (*CRTISO*), geranylgeranyl diphosphate synthase 2 (*GGPPS2*), and 1-deoxy-D-xylulose-5-phosphate synthase (*DXS*), were reduced by chilling, as was polygalacturonase (*PG*), pectin esterase1 (*PE1*),  $\beta$ -galacturonase (*TBG4*), expansin (*LeExp1*), and xyloglucan endotransglucosylase/ hydrolase 5 (*XTH5*), associated with cell wall-modification, as well as alcohol dehydrogenase 2 (*ADH2*) and alcohol acyltransferase (*AAT*). Fruit stored for 1 week showed an increased or unchanged gene expression of aminocyclopropane-1-carboxylate synthase genes *ACS2*, *ACS4*, whereas reduced *ACS2* and *ACS4* expression was observed in fruit stored for 4 weeks. *ACO1* expression increased in chilled fruit during cold storage, but decreased after removal to 20 °C. Fruit stored for 1 and 2 weeks showed a transient increase in *NR* expression, while the reduced *NR* expression was observed in fruit stored for 4 weeks through ripening. In contrast, *LeETR1* was induced by chilling during cold storage, and then decreased after removal to 20 °C. Reduced *LeETR4* expression was observed in fruit stored for 4 weeks, while fruit stored for 1 and 2 weeks showed slightly reduced *LeETR4* during early state of ripening. The expression of *LeCTR1* was induced during cold storage, but the expression levels decreased after removal to 20 °C. The expression of *LeMADS-RIN*, encoding a ripening-specific transcription factor Le-MADS-RIN, was increased after 1 week of cold storage but was reduced after 4 weeks. Fruit stored for 4 weeks showed reduced *LeMADS-RIN* expression during ripening, while fruit stored for 1 week showed reduced *LeMADS-RIN* after 3 d of ripening.

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### (108) Postharvest Quality of Grape Tomatoes for Vegetable Trays

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Grape and cherry tomatoes now constitute about 24% of the value of all tomatoes sold in U.S. supermarkets. For performance in vegetable trays, the differences among grape tomato varieties were not as important as overall freedom from defects (shriveled, mechanical damage) and the stage of ripeness. Marketing grape tomatoes as components of fresh-cut vegetable trays exposes them to temperatures of 5 °C or below, often in combination with modified atmospheres. These conditions are at odds with usual storage and handling recommendations for good tomato quality. Several storage studies were conducted on different varieties of grape tomatoes. At 5 °C, grape tomato fruit (orange-red) could

be stored up to 18 days and still be of marketable quality if kept cold. Continuous storage at 5 °C resulted in minimal weight loss (a significant cause of quality loss in grape tomato), no lycopene synthesis, retention of Vitamin C, but decreases in sugar concentrations. However if fruit were transferred from 5 °C and 10 °C to warmer temperatures, typical chilling injury symptoms (decay, poor color) occurred as expected on the fruit stored at 5 °C but not on those stored at 10 °C. Controlled atmospheres of 3 or 10% oxygen with 0, 7, 12, or 18% carbon dioxide provided little benefit but were tolerated by grape tomatoes for up to 3 weeks at 5 °C (based on visual appearance, discoloration, decay, off-odors, and changes in sugars, Vitamin C, and ethanol and acetaldehyde concentrations). Near ripe high quality grape tomatoes perform well as components of fresh-cut vegetable trays under temperatures and atmospheres not recommended for tomatoes. Future work should focus on the eating (sensory) quality of the grape tomatoes under these conditions.

### **(109) Evaluation of the Impact of Hot Water Treatment on the Sensory Quality of Fresh Tomatoes in Cold Storage**

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Minimizing the effects of chilling injury during shelf-life is important for maintaining the sensory quality of fresh tomato fruit. Postharvest hot water treatments within certain limits of exposure time and temperature have been shown to increase resistance of tomatoes to chilling injury. Mature-green (MG) and Breaker/Turning (BT) 'BHN-602' tomatoes harvested in spring 2009 were submerged in water at 25 (control) or 52 °C for 5 minutes. MG fruit were then exposed to 100 µl/L ethylene for 2 days at 20 °C to uniformly initiate ripening; any fruit not exhibiting external red color after the ethylene treatment were discarded as immature. The remaining MG and BT fruit were stored at 5, 12.5, or 20 °C. After 1 week, tomatoes were transferred from 12.5 and 5 °C to 20 °C until fully ripe. Ripeness was evaluated by measuring color (CIE a\*) on the blossom end of the fruit until a\* reached an acceptable value. When selected as fully ripe, fruit firmness, sugars, organic

acids, and volatile compounds were measured and a trained panel evaluated sensory quality using 15 descriptors measured on a 16-point scale. Sensory data were analyzed by several methods of multivariate analysis including principal component analysis (PCA) and agglomerative hierarchical clustering (AHC). PCA and AHC showed that tomatoes grouped into three clusters defined by their sensory descriptors. Fruit stored only at 20 °C were clustered together regardless of heat treatment and had the highest perceived firmness as shown by the PCA biplot. Fruit harvested at the MG stage were characterized by the sensory quality descriptors 'overall tomato', 'fruity', 'sweet' and 'salty', regardless of water treatment temperature and storage temperature. Tomatoes at the BT stage had high scores for 'mealiness' and 'sourness', except those that were treated with 52 °C water and stored at 5 °C; those tomatoes had high scores for 'earthy/musty' aroma and flavor. When the experiment was repeated in fall 2009, tomatoes stored at 20 °C had the highest scores on PC1 with descriptors of 'tomato', 'fruity', and 'vine' aroma and flavor. BT fruit were characterized as 'mealy', and MG fruit were described as 'sour', 'salty', and 'earthy'. However, one group of fruit was positively affected by the treatments as they had positive scores on PC1; these were MG and BT fruit treated with 25 or 52 °C water then stored 1 week at 12.5 °C, and BT fruit without heat treatment stored at 5 °C for 2 weeks.

*Specified Source(s) of Funding:* personal funding

### **(110) Kinetic and Stability Studies of Pectin Methylesterase from Hot Peppers, (*Capsicum frutescens* L.)**

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A major concern of pepper sauce manufacturers is separation of sediments and layering of sauce after bottling. Separation is an undesirable production condition because consumers view this as a defect. Pectins play an important role in sauce processing since it influences the final consistency of the sauce, especially those having no additional stabilizers. Failures in pectin stability can sometimes be related to the presence of enzymes. Understanding how the pectin enzymes function during lactic acid fermentation of salted pepper mash is a necessary step in controlling the enzymatic activity, and thereby reducing production cost and the risk of having poor quality food product. In most cases, complete enzyme inactivation is the target. In

the case of pepper products, there is very little information available in the literature on the effects of active enzymes on fermenting pepper mash quality or the characteristics of pectin methylesterase (PME) from hot pepper in terms of varied pectin substrate solutions, salt concentration, pH, and temperature optima. Tabasco peppers (*Capsicum frutescens* L.) plants were used in this study and were placed in a polyethylene covered greenhouse on the Louisiana State Univ Hill Farm Teaching Facility. The experiment included a micro-irrigation system with watering based on the seasonal temperatures. PME was extracted from mature red-ripe peppers and partially purified by weak anion-exchange and affinity chromatography. PME activity was spectrophotometrically assessed, absorbance read at 620 nm by measurement of methanol release through a colorimetric assay based on the condensation of aldehyde with MBTH under neutral conditions using citrus pectin as the substrate. Based on our SDS-PAGE results, two major bands were present at 22 kDa and 36 kDa. Our research revealed hot pepper PME  $K_M$  value was  $0.23 \pm 0.05$  mg/mL and the maximum rate ( $V_{Max}$ ) was  $48.1 \pm 3.1$  nmoles methanol/min. The enzyme appears to be inactivated at concentrations of 8% (1.4 M) and above and lost most of its activity above pH 8.5. It exhibited 85% activity at 30 °C and decline in activity at 50 °C (65% activity) and higher. Our study of PME extracted from hot pepper will help characterize the enzyme further, to aid in addressing issues of the enzyme activity in the food industry.

*Specified Source(s) of Funding:* Louisiana State Univ Food Science Department

### **(111) Effect of Low Temperatures on Carbohydrate Accumulation in Garlic Leaves (*Allium sativum*) during Their Development**

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The fructans constitute 70% of the dry matter of garlic bulbs, these are polymers of fructose linked at one sucrose molecule; the primary sugars are synthesized in the leaves, transported and accumulated in the bulbs. This process is influenced by the thermo-photo period, indicating that low temperatures and short photoperiod at the beginning of plant development improve the bulbs quality and a greater fructans accumulation. Not known as the initial thermal-photo period modifies the metabolism and accumulation of fructans in garlic. We studied the effect of low temperatures and short photoperiod in the development plant and in the content of sugars and fructans in garlic leaves. Garlic bulbs CV 'California Late' were stored 4 weeks at 10 °C, and their cloves planted in pots and grown 30 days at different environments controlled: A) 13h/0 °C in darkness and 11h/16 °C in white light; B) 13h/5 °C in darkness and 11h/16 °C in white light; C) 13h/10 °C in darkness and 11 H/16 °C in white light; D) 13h/22 °C in darkness 11 h/22 °C in white light. Later, the

thermal photo period of A, B and C were changed at 11h/10°C in darkness and 13 h/22 °C in white light. The experiment D (22 °C) remained at the same temperature but changing its photoperiod (13h light and 11h darkness). Under these latter conditions, three plants were taken periodically and the weight of the canopy, number of leaves per plant and the glucose, fructose, starch and fructans contents in the second leaf of each plant were registered. Plants at 0 °C showed greater total and canopy weight and more leaves (12) than plants grown at 5 and 10 °C (9). After 109 days after sowing (DAS), the fructans content was larger (28 g/100 g) in plants at 0 °C than plants grown at 5 °C (24 g/100g) registered at 95 DAS; also the starch content was higher (6 mmols starch/mm<sup>2</sup>) at the 118 DAS respect of plants grown at 5 °C (4 mmols starch/mm<sup>2</sup>); out of those days did not be detected starch in all experiments. At 10 °C lower contents of fructans were observed without starch accumulation; plants grown continuously at 22 °C did not show starch or fructans accumulation. Throughout the growing cycle at 10 °C, the sucrose was detected but not glucose or fructose, indicating possibly a high activity of sucrose synthesis.

*Specified Source(s) of Funding:* CONACyT Mexico

### **(112) Evaluation of the Impact of Hot Water Treatment on Flavor Compounds of Fresh Tomatoes**

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In June 2008, two varieties of tomato fruit, Florida 47 F47) and Tasti-Lee (TL), were harvested mature green and submerged in water at 25 °C (control) or 52 °C for 5 minutes or 54 °C for 2.5 minutes. The fruit were then gassed with ethylene at 100 ppm for 48 hours and ripened at 20 °C. Ripeness was evaluated by measuring color (CIE a\*) on the blossom end of the fruit until a\* reached an acceptable value. When selected as fully ripe, fruit firmness, sugars, organic acids, and volatile compounds were measured on half the fruit while a trained panel evaluated sensory quality on the other half. The remaining fruit was homogenized for 30 s and 40 mL of homogenate was removed and frozen at -20 °C for subsequent sugar and acid analysis by HPLC. After 3 min, 10 mL saturated CaCl<sub>2</sub>

was added to 25 mL of homogenate that was flash frozen and stored at -80 °C for aroma volatile analysis using GC-FID on polar and non-polar columns. There were significant differences for glucose, fructose, citric and malic acids. Sugar differences were due to variety where TL had higher levels of sugars than did F47, especially when heated. F47, however, exhibited lower levels of citric and malic acids when heated at 52 °C for 5 min compared to controls. There were significant differences for three aldehydes (hexanal, *trans*-2-hexenal, *trans*-2-heptenal), two alcohols (ethanol, 2+3-methyl butanol), three ketones (acetone, 1-penten-3-one and furanone) as well as 1-nitro-2-phenylethane and methsalicylate of the 28 aroma volatiles measured that are important to tomato flavor. These differences were sometimes due to treatment and sometimes more related to variety, but often heating F47 resulted in an increase in volatile levels, which was evident in multivariate analysis. The experiment was repeated in December, 2008. There were no differences in glucose, fructose or malic acid, but citric acid was reduced in fruit heated at 52 °C for 5 min for F47 and for both treatments for TL compared to controls. There were significant differences for 8 aldehydes (*trans*-2-penanal, *cis*-3-hexenal, 2+3-methylbutanal, *trans*-2-hexenal, *trans*-2-heptenal, phenylacetaldehyde, methional and benzaldehyde), 3 alcohols (2+3-methylbutanol, linalool and 2-phenylethanol), two ketones ( $\beta$ -ionone and furanone) as well as 1-nitro-2-phenylethane for F47. Again, sometimes the 52 °C treatment increased volatile levels. In conclusion, there were differences between varieties, but heating sometimes increased aroma for F47 and reduced acids in both varieties.

### (113) Influence of Chilling and Heating Stress on Oxidative Parameters and Antioxidant Systems in Tomato

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'Tasti-Lee' and 'Sanibel' tomatoes were chilled at 5 °C air for 4 day or heated at 52 °C water for 15 min. Oxidative parameters, antioxidant compounds and antioxidant-related enzymes in the tomatoes were measured immediately after treatment and four days after transfer to 20 °C. For 'Tasti-Lee', heating did not affect content of malondialdehyde (MDA), an indicator of lipid peroxidation, or hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>). Ascorbic acid (ASA), dehydroascorbate (DHA), glutathione (GSH) and oxidized GSH (GSH disulfide, GSSG) remained unchanged or slightly decreased. The activities of enzymes, related to scavenging of reactive oxygen species (ROS), such as superoxide dismutase (SOD), ascorbate peroxidase (APX), peroxidase (POD) and catalase (CAT), and related to ASA-GSH cycle, such as mono-

dehydroascorbate reductase (MDHAR), dehydroascorbate reductase (DHAR) and glutathione reductase (GR), were induced by heating treatment. However, chilling increased MDA content, and decreased content of ASA, DHA and GSH. Chilling also induced the ROS scavenging-related enzyme activities, but did not affect or slightly inhibited ASA-GSH cycle-related enzymes. For 'Sanibel', chilling also increased MDA content. Heat treatment reduced ASA and DHA levels, although it induced the activities of POD, CAT, DHAR and GR. The results indicate that both heating and chilling induced ROS scavenging-related enzymes, and protected the tissue from ROS. Heating also induced the activities of ASA-GSH cycle-related enzymes, thus maintaining ASA, DHA and GSH contents and the antioxidant capacity of tissue to counteract oxidative stress. This is also why heating often is used as a pre-treatment before storage to improve the storability of fruits and vegetables and protect against chilling injury. On the other hand, chilling caused loss of antioxidant capacity by inhibiting ASA-GSH cycle related enzymes, and decreasing ASA, DHA and GSH contents.

### (114) Effect of Two Edible Coatings to Preserve Storage Life and Quality of Tomato Fruit during Storage

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Tomatoes (*Lycopersicon esculentum* Mill.) are one of the most widely consumed fresh vegetables in world. Consumers judge the quality of fresh tomatoes by their firmness, color and taste, attributes that are related to fruit ripening and shelf life. Major losses in tomato quality and quantity occur between harvest and consumption; therefore, it is necessary to develop new methods to extend the shelf life of this commodity during post-harvest. One method is the application of edible coatings. The purpose of the present study was to evaluate carnauba and mineral oil coatings for their ability to preserve post harvest quality of tomatoes (cv. Grandela). Sta-fresh 2505™ (carnauba) and Sta-fresh 151™ (mineral oil) coatings were applied on tomatoes at two maturity stages (breaker and pink). The quality of tomatoes was evaluated periodically at 0, 5, 10, 15, 21, and 28 days of storage at 10 °C, plus 2 days at 20 °C. For respiration rate analysis, tomatoes were kept at 20 °C for 16 days. The present

study showed that coatings were effective in the preservation of tomatoes. Respiration rate, color, weight loss and enzyme activity were positively affected by mineral oil coating in both maturity stages. At the beginning of the study CO<sub>2</sub> production was reduced by 38% and 46% when applying the mineral oil coating on breaker and pink tomatoes, respectively; this reduction was observed during almost all the storage period. Ethylene production was entirely inhibited at the beginning of the study on both maturity stages, when mineral oil coating was applied. Ethylene production was kept significantly low during the first nine and 12 days of storage for breaker and pink stage, respectively. At the end of storage, mineral oil coating reduced tomato weight loss up to 70% and 46% for breaker and pink stage, respectively; the change of color was successfully retarded too. However, tomatoes treated with mineral oil showed an increase on the production of acetaldehyde and ethanol at day 5 of storage for both maturity stages. No effect on firmness, acidity titratable and pH were found by the application of the coatings. Tomatoes treated with carnauba wax showed a similar pattern that control fruits for all variables studied, with exception of weight loss, where retention of weight was observed when applying carnauba coatings. In conclusion, mineral oil coatings could be a good alternative for preserving quality and extending the shelf life of tomato fresh fruit.

Tuesday, August 3, 2010

Springs F &amp; G

## Teaching Methods

### (204) The Ute Ethnobotany Learning Garden

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An ethnobotany garden is a demonstration and teaching garden that displays how native cultures used native plants in daily life. The Ute Ethnobotany Learning Garden is located on lands occupied for at least 500 years by the Ute Indian people. The end product is to provide a Living Laboratory/Learning Garden available to local schools, clubs, senior groups and visitors to the area. The scope of the lesson plan is broad, from adaptive vegetable gardening for people with limited mobility and/or limited space, teaching strategies for living and eating from a xeric landscape, teaching traditional Native American gardening skills, exhibiting traditional Ute structures and developing miniature plant communities with representative species from the life zones in and around the Grand Valley of Western Colorado. Twice a year (June and September) funding provides for Ute students and elders from the Uintah and Ouray Reservation in Utah to visit the garden and learn about the native plants and how they were used in ancestral times. During these visits minipowwows are scheduled and local residents encourage to visit and to learn from the Ute Indians. Funding also permits visits to nearby Ute archaeological sites located on public lands where students learn from their elders about their cultural heritage. This project provides the foundation for interpreting Ute traditional culture and plant use, shares information on the value of plants

and their role in resource management on public lands, teaches stewardship of natural resources, exhibits life zones and the plants used by the Ute people for food, fiber and medicine and teaches the public about native landscaping and low water-use plantings. This project creates a unique opportunity to contribute to the lives of Ute young people and provides encouragement to students of all ages and cultures to learn about the natural and cultural world. The Ute Ethnobotany Learning Garden is a joint project of the U.S. Department of the Interior Bureau of Land Management, the Department of Agriculture U.S. Forest Service, Colorado State Univ Extension, Mesa State College and the Northern Ute Indian Nation, Uintah and Ouray Reservation. This partnership is developing 2.5 acres of undeveloped county land adjacent to the existing demonstration gardens and Arboretum at the Mesa County Colorado State Univ Extension office at the Mesa County fairgrounds.

### (205) Assessment of Integrative Learning on Student Learning Outcomes in Higher Education Programs

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Is there enhancement of student skill acquisition and cognitive development through the use of integrative learning in comparison to more traditional curricular designs? Integrative learning claims to connect learning across courses and disciplines, and between campus and community to prepare students for making informed decisions in their personal, professional, and civic life. Student learning is demonstrated by intellectual, personal and disciplinary development through understanding and connecting knowledge from multiple fields, applying theory and practice to various settings, utilizing diverse and even contradictory views, and understanding issues contextually. We test the hypothesis that highly integrative curricula structure enhances student learning and cognitive development over the relatively short duration of a baccalaureate degree program by measuring the differences among student learning outcomes within traditional segregated discipline oriented curricula and of students immersed in curricula that are designed to place major areas of study in common courses. Specifically, undergraduate student learning outcomes within three units in the College of Agriculture and Natural Resources (CANR) at Michigan State Univ will be measured over a six year longitudinal study. An examination of data from the Learning Environment Preferences (LEP) survey

instrument reveals that Perry position 2 (“what to learn”) for 48% of the survey respondents received a score of 26 or greater. Nearly half the surveyed students have a significant (greater than 25) preference for this level of intellectual development. Similar to the Perry position 2 data, for the Perry position 3 (“how to learn”) scores, 24% of the students showed a strong preference (scores of 50 or higher). However, for higher levels of intellectual development (Perry position 3 and Perry position 4, respectively), only 10% of the students showed a strong preference for position 3 (“how to think”), and no students had a score over 46 for position 4 (“how to judge”). Given that 88% of the students surveyed were freshman or sophomores, these findings support earlier research, that indicate students achieve higher levels of intellectual development in later years. Twenty-four percent of respondents had scores of less than 40 across all four Perry positions, indicating that they have developed a wide range of learning approaches equally; or they may not have a clear sense of their own preferences. Spring 2009-10 semester survey data will be presented.

### **(206) Using Moodle and Multimedia Elements for Online Course Delivery at Land Grant Institutions in the Western Pacific**

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Moodle is the current course management system used for online course delivery at the Univ of Guam. Currently, courses in the Tropical Agricultural Science Program are being developed for online delivery in the Western Pacific. Some islands in this region have limited internet bandwidth making the development challenging. For remote regions, Moodle can be set up to load files from DVDs. Initially courses with labs were developed for hybrid delivery which includes weekly face-to-face meetings. The use of multimedia is very useful for expanding the students' course experiences. Multimedia formats used include images, podcasts (m4b for lectures) and videos. The podcast format is an efficient method for delivery of powerpoint slides synchronized with audio. Multimedia elements can be used by the instructor for lectures, quizzes, lessons and assignments. Students can use multimedia elements to submit assignments that enabling them to share their experiences from off-campus lab activities.

*Specified Source(s) of Funding:* NIFA-Serd Grant

### **(207) Utilizing Graduate Students' Firsthand Horticultural Experience in an Undergraduate Production Systems Course**

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Teaching experience is important in a graduate student's pro-

fessional development. However, opportunities are limited. Our department has only three graduate teaching assistants per semester, each assisting in three or four courses. Students can be a graduate teaching assistant for up to two years. Thus, there is a lack of opportunity for other graduate students to gain teaching experience. We describe how graduate students were integrated into an undergraduate horticulture production systems course as guest lecturers. Certain graduate students, who were in the TPSS 654 Communications in the Sciences course, were asked to make a presentation in a lecture or laboratory section of TPSS 300 Tropical Production Systems. Students were selected based on their firsthand knowledge and experience in topics relevant to TPSS 300. If a student consented to guest lecture, we discussed in person or via e-mail the specific topic they were to speak on. We also discussed what kind of laboratory experience they could provide such as a tour of their laboratory, observing their experiments in the greenhouse, or going on a campus tour. In addition, a TPSS student who had graduated and previously taken TPSS 300 was asked to speak about his sod farm from an owner's perspective. We also asked several students in the current TPSS 300 course to speak about our college's Sustainable and Organic Farm Training organization and on-campus vegetable gardens, example of urban agriculture. Graduate students spoke on diverse topics including orchid nurseries, innovative horticultural enterprises in China, tissue culture, bioreactors for micropropagation, operation of a tissue culture laboratory, vermicomposting, aquaponics with lettuce and tilapia, setting up a hydroponic system, campus landscape facilities and operations, Varroa mite problem on honeybees, and beehives and pollination. Speakers used PowerPoint presentations, tours of laboratories and greenhouses, on campus tours, and laboratory exercises. The integration of graduate and undergraduate guest lecturers into our undergraduate course worked well, providing benefits to both the speakers and the students. TPSS 300 students learned firsthand from knowledgeable speakers who were their peers. Graduate students gained valuable teaching experience. The problem of asking the same faculty to guest lecture in TPSS 300, some of which had given the same talk in other TPSS courses, was minimized. Lastly, this experience helped bridge the gap between our graduate and undergraduate students who sometimes have minimal contact and interaction in our department.

### **(208) The Impact of Audio Technology on Undergraduate Instruction in a Study Abroad Course on English Gardens**

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The use of digital technology in higher education can provide students with an effective supplement that enhances learning of course content outside the traditional classroom. This study investigates the effectiveness of audio podcasts as a means of disseminating course content to students in informal learning environments like public gardens and parks. The investigation is organized into three major areas: (a) student's utilization of audio podcasts; (b) the effects of audio podcast on knowledge gain; and (c) students' perceptions of audio podcasts. Twenty-two undergraduate students participated in a 21-day study abroad course on the history of the English landscape, garden design, and horticulture, a course that included instruction in both the classroom and on-site at public garden locations throughout southern England. All 22 students were provided with two to four pages of written text describing key historic and horticultural information regarding 12 English gardens. Instructional audio narratives for iPod of 20–30 min duration were developed for each of these 12 historic gardens. These gardens varied substantially in overall complexity, from small gardens with limited interpretive content, to massive gardens having a very long history and more intense management philosophy. Three gardens of high, moderate, and minimal complexity were selected to test the effectiveness of these audio narratives as a supplement to classroom lecture and available written text. The students were divided into two groups of 11, with one group provided an audio narrative, and the other having audios withheld. Immediately after the site visit to each of these three gardens, all 22 students were given both a written and oral exam covering both historical and horticultural aspects of these gardens. Written exam scores differed little between audio users and non-users. However, students with the audio narratives scored significantly higher on two of the three oral exams. Rather than multiple choice questions as in the written exams, the oral exams utilized more open-ended questions that required the students to integrate course content in order to demonstrate a higher level of overall meaning. In a subsequent survey, the audio users expressed positive reactions to this learning technology, and these reactions, together with the positive learning outcomes, suggest that audio can enhance teaching effectiveness in informal learning environments like public gardens and parks.

*Specified Source(s) of Funding:* self

### **(209) Student Assessment of the Relative Value of Video Tutorials as a Learning Resource in a Computer-aided Drafting Course**

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Landscape designers rely on computer-aided drafting software to create technical drawings that are essential to the implementa-

tion of landscape designs. These drawings may include master plans, planting plans, construction details, and other drawings deemed necessary for a particular project. Computer literacy courses in the Department of Horticulture at Penn State introduce landscape contracting students to current software technologies utilized within the landscape industry. Horticulture 220, *Advanced CAD Applications*, focuses on computer-aided drafting software, specifically AutoCAD. To improve understanding of computer-aided drafting concepts during the Spring 2009 semester, the instructor used screen capture software to create video tutorials demonstrating various process and techniques. These tutorials were made available for students to access during non-class hours. At the conclusion of the course, students were surveyed to determine the effectiveness of the supplemental video tutorials in communicating course content. A survey consisting of 10 questions was administered to 23 students. Seventy four percent indicated that they had watched at least one of the video tutorials. The survey also asked students to rank their preferred method of learning among the following: lecture, live demonstration, self exploration, text book, and video demonstration. Weighted scores were calculated for each method of learning by multiplying each rank by the frequency of response. Mean rankings were calculated by dividing the weighted scores by the number of respondents. Live demonstration received the highest mean ranking of 1.43. Lecture, self exploration, and video demonstration received mean rankings of 3.00, 3.08, and 3.13 respectively. Text book received the lowest mean ranking of 4.47. The results indicate that supplemental video tutorials are valued by students as a learning resource, and that in-class demonstrations are the preferred method of learning.

### **(210) New Online Course Examines Critical Water Issues Related to Irrigation in Urban Watersheds**

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The area of land covered with turfgrasses is increasing with urbanization, which may have significant implications for water quantity and quality in urban watersheds. Excessive irrigation may waste limited water resources and increase the potential for leaching or runoff. Residential lawns represent the largest sector of turfgrass cover and the greatest opportunity for reducing water waste and improve water quality in urban watersheds. A new online lawn-and-landscape irrigation course entitled "Water Issues in the Lawn and Landscape" is being offered at Kansas State Univ to examine critical water issues related to



irrigation in urbanizing watersheds, with an emphasis on water quality and quantity. The course is designed for students and professionals in industry who want to enhance their knowledge and careers through distance education. This class is co-taught by four professors, each contributing from their own area of expertise during the design of the course. In addition to conveying relevant content to students, the professors focused on the process in which the material was presented. Specifically, they emphasized creating sense and meaning while developing each assignment and lecture. If a lecture makes sense to the learner and there is meaning for the learner, the probability of storing the information is very high. Students enrolled in the course learn about the interrelatedness of correct irrigation practices and water quality and quantity, and how to protect water resources through application of science-based irrigation practices. Seven topical modules are presented in developmental order: homeowner perceptions; water availability and quality; relationship between irrigation practices and water quality; weather-based irrigation decision making; low-water-use-lawns and landscapes; auditing irrigation systems; and changing water users' habits. Because class participants are primarily students and professionals in the turfgrass industry, they are in ideal positions to collectively improve irrigation practices by residential homeowners. These professionals could communicate to homeowners the importance of sustainable irrigation practices in their lawns by using knowledge and communication skills gained through their coursework.

## Tuesday, August 3, 2010 Springs F & G Vegetable Crops Management 1

### (274) Sugar Snap Pea Quality Changes in Relation to Storage Temperatures and Atmospheres

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Sugar snap peas are increasing in importance as components of vegetable trays. Sugar snap peas (cv. Sugar Daddy and Sugar Snap) were stored at 5 °C in air or air or a range of controlled atmospheres (3% O<sub>2</sub> alone or with 6, 12, or 18% CO<sub>2</sub>, and 1 or 10% O<sub>2</sub> with 12% CO<sub>2</sub>). After 12 days storage, peas in air and all atmospheres were of marketable quality. By 15 days, both cultivars were injured by the 3% O<sub>2</sub> + 18% CO<sub>2</sub> and 1% O<sub>2</sub> + 12% CO<sub>2</sub> atmospheres. The best storage atmospheres for 18 days were normal air, 3% O<sub>2</sub>, 3% O<sub>2</sub> + 6% CO<sub>2</sub>, and 10% O<sub>2</sub> + 12% CO<sub>2</sub>. Sugar and Vitamin C concentrations declined with time under all storage conditions, but were not notably affected by the atmospheres. Very high concentrations of acetaldehyde and ethanol were found in peas stored in 1% O<sub>2</sub> + 12% CO<sub>2</sub>, with significant increases after 6 days of storage. Increases in fermentative volatiles were also observed in the 3% O<sub>2</sub> +

12% or 18% CO<sub>2</sub> atmospheres. The same 3 atmospheres also resulted in increased electrolyte leakage and ammonia concentrations. In another experiment the same two cultivars were stored at 0 °C in air and at 5 °C in air or CA (3% O<sub>2</sub>, 3% O<sub>2</sub> + 6%CO<sub>2</sub>, 3% O<sub>2</sub> + 12% CO<sub>2</sub>, or 10% O<sub>2</sub> +12% CO<sub>2</sub>) for up to 24 days. Visual quality evaluations indicated that all peas were marketable after 24 days under all conditions. Sugar and Vitamin C concentrations declined under all storage conditions, but concentrations were not affected by the atmospheres used. Other indicators of stress (acetaldehyde and ethanol, ammonia, and electrolyte leakage) also showed that the peas tolerated all storage conditions. Respiration rates were similar among 3 cultivars and averaged 11.5, 16.5, and 32 μL CO<sub>2</sub>/mg-h at 0, 5, and 10 °C, respectively. The most beneficial condition for sugar snap peas is storage in air at or near 0 °C. At 5 °C, some of the atmospheres tested offer modest benefit over air storage at that temperature.

### (275) Yield Response of Swiss Chard to Nutrient Solution Management and Propagation Substrate in Nutrient Recirculating Hydroponic Culture

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Within the small-scale hydroponic industry, approaches to nutrient solution management in recirculating hydroponic culture are variable. Research information about the influence of nutrient solution management (*SMGMT*) on crop yield responses in commercial recirculating hydroponic culture is limited. The influence of nutrient solution renewal (*RNWL*) vs. replenishment of depleted nutrients (*RPLN*), and propagation substrate (*SBSTR*) on leaf yield of Swiss chard (*Beta vulgaris* L. 'Lucullus'), were evaluated in a commercial Nutrient Film Technique (NFT) hydroponic system. Two-week old seedlings of Swiss chard 'Lucullus' were transferred into NFT culture at the second true-leaf stage and grown under controlled environment greenhouse conditions with a soluble fertilizer solution (15N-2.2P-12K) at 200 mg N L<sup>-1</sup>. The treatments comprised of two nutrient management techniques (*RNWL* and *RPLN*), and two propagation substrates (Oasis™ or Rockwool cubes). At 63 days after transfer (DAT) into NFT culture, *RNWL* significantly ( $P \leq 0.001$ ) increased mean per plant leaf count (LC), leaf fresh weight (LFW), leaf dry weight (LDW) and leaf area (LA). Across *SBSTR*, these parameters were respectively, 18%, 82%, 45%, and 48% higher with *RNWL* than *RPLN*. Similarly, mean LC, LFW, LDW and LA were significantly ( $P \leq 0.01$ ), higher in Rockwool than Oasis™ cubes. Across *SMGMT*, these parameters were respectively, 14%, 56%, 58% and 25% higher in Rockwool than Oasis™ cubes. However, with *RNWL*, *SBSTR* had no significant ( $P = 0.05$ ) effect on LC. Interaction between *SMGMT* and *SBSTR* was not significant ( $P = 0.05$ ). Within *SMGMT* only LFW and LA were significantly ( $P \leq 0.05$ )

higher in Rockwool than Oasis cubes with *RNWL*, whereas mean *LC*, *LFW*, *LDW* and *LA* were highest in Rockwool cubes with *RPLN* ( $P \leq 0.01$ ). These observations suggests that *RNWL* with Rockwool substrate provided better growing conditions for optimum yield of Swiss chard in NFT culture under the conditions of this experiment.

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### **(276) Strip-tillage, Compost, and Planting Density Effects on Carrot Quality and Yield**

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Biotic and abiotic stresses during carrot stand establishment can greatly reduce carrot quality and yield. Practices which increase soil organic matter including reduced-tillage, cover cropping, and compost addition may improve crop resilience to these stresses. In Michigan, innovative carrot growers are experimenting with use of pre-established barley or wheat cover crops combined with strip-tillage to provide wind-protection for vulnerable carrot seedlings while building soil health. The central objectives of this research were to evaluate the interactive effects of tillage (strip vs conventional) and compost (none vs 2.8 T/A) on weed suppression, soil N dynamics, soil enzymes considered short-term indicators of beneficial changes in soil organic matter, and carrot quality and yield. A secondary objective, carried out on-farm, was to evaluate the impact of planting density on yield and culls of three processing carrot varieties. Key findings from 2009 field trials included: 1) strip-tillage had no effect on N-dynamics, soil enzyme activity or carrot quality and yield relative to conventional tillage; 2) compost applications resulted in higher yields and lower percentages of forked carrots in a field heavily infested with root-knot and lesion nematodes; and 3) higher planting densities improved yields and reduced the percentage of culls from 17% to 2% in a grower field with substantial stand losses due to heavy early rains. Our results suggest that strip-tillage, seeding rate, and compost application are all useful tools for reducing the risk of yield losses due to biotic and abiotic stresses in carrot production systems.

*Specified Source(s) of Funding:* Michigan State Univ Project GREEN

### **(277) Effects of Calcium Fertilizers and 1-MCP on Cantaloupe Fruit Firmness**

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California and Arizona produce over 80% of all cantaloupe (*Cucumis melo*) produced in the United States. Shipments of cantaloupe from CA and AZ to the east coast of the U.S. and Canada are very common and take about 4 days. Long transportation time could reduce shelf-life or result in soft fruit, which is the most common reason for shipment rejection by distributors. Calcium has been shown to play a significant role in maintaining cantaloupe fruit firmness and extending shelf-life. This study investigated the potential of applying calcium fertilizers through berried drip tape to mitigate the effect of high sodium/calcium ratio in soil and irrigation water to increase fruit firmness. Four compounds were used to increase calcium supply to cantaloupe variety Olympic Gold in a grower's field at Harquahala Valley, AZ:  $\text{CaCl}_2$ , an EDTA-chelated calcium carbonate (Agri-Cal), a micro-encapsulated calcium carbonate (*Mainstay Calcium*), and a carboxyllated organic compound to reduce salt and sodium in the soil (Soilex). The compounds were supplied every 10 days for 3 times through drip tape starting from the first female flower. After harvest, half of the sampled cantaloupe fruits that were full slip and full color were treated with 1-methylcyclopropene (1-MCP) in a refrigerated trailer for 12 hours to test its effects on fruit storage quality. The 1-MCP treated fruits and control were then stored in 3.5 °C cooler for 10 and 20 days. There were no significant interactions between calcium fertilizer and 1-MCP treatments. Calcium fertilizer treatments did not significantly affect firmness and Brix of fruits that were full slip but not full color and fruits that were full slip and full color. After 10 days' storage, fruit firmness decreased 17% in the 1-MCP treatment and 37% in the control treatment. The difference in fruit firmness between 1-MCP and control treatment was similar after 20 days storage. The Brix was not affected by 1-MCP treatment during the storage. Calcium fertilizers did not change fruit firmness in this particular study, but fruits in the 1-MCP treatment maintained significantly higher fruit firmness during the 20-day storage time.

### **(278) Fruit Yield in Seedless Watermelon (*Citrullus lanatus* L.) as Affected by Irrigation Rates**

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There is an increasing concern about sustainable use of water in vegetable production. Research efforts are intended to increase water and fertilizer use efficiency. Watermelon is often irrigated excessively resulting in water waste and nutrient leaching. The objective was to evaluate the effects of irrigation rates on plant growth and fruit yield and quality in watermelon. The experimental design consisted of a randomized complete block with five treatments [irrigation rates (33%, 67%, 100%, 133%, and 167% the rate of crop evapotranspiration)] and four replications. We used a seedless watermelon cultivar ('Tri-x 313' as female, and 'Ace' as the pollenizer) that is commonly grown in the southeast U.S. The incidence and severity of *Phytophthora capsici* were negligible, thus, the effects of irrigation rate on the disease could not be determined. Fruit yields and average fruit weight were not drastically affected by irrigation rate, although fruit yields were lowest at the lowest irrigation rate (33% ET). Fruit quality was affected by irrigation as shown by the reduction in the concentration of fruit soluble solids with increasing rates of irrigation. In conclusion, watermelon plants irrigated at 67% the rate of crop evapotranspiration had fruit yields and quality similar to plants irrigated at 100%-167% the rate of crop evapotranspiration. Thus, there seems to be potential for significant reductions in the current rates of water application to watermelon in the southeast U.S. with the consequent increases in water (and possibly fertilizer) use efficiency.

*Specified Source(s) of Funding:* National Watermelon Growers Association

### (279) Effect of Color of Plastic Mulching and Organic Mulching on the Yield Components and Quality of Watermelon (*Citrullus lanatus* Schard.) 'Royal Flush'

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Mexico contributes about 1.41% to world horticultural production, and is in sixth place as an exporting country. Horticultural cultivation in Mexico has increased about 80% of the acreage

destined to new technologies, such as plastic mulching as an alternative to handle the environmental conditions, improve development, make use of the inputs, control plant sanitary problems, and increase the yield and quality of watermelon in horticultural areas of our country. There is an impressive diversity of colors and thickness of plastic mulches used for agricultural purposes. The aim was to evaluate the effect of color mulching and organic mulching on the yield and quality of watermelon fresh production. The colored plastic mulches were transparent, black, white, brown, aluminum/black, black/aluminum; and rice straw was used as organic mulch, and bare soil as control. The treatments were arranged in a complete random-block design with four replications. The data were analyzed by ANOVA and means separated by Tukey test ( $P=0.05$ ). Significant differences were obtained in the variables days to blooming and number of fruits (Pr.0.029). White and aluminum/black mulches showed the latest blooming dates with 57, and 57.7 days, they also showed 11.3, and 12 fruits per plant, respectively. In the variables fresh fruit and yield per plot significant differences were obtained (Pr. 0.0001), the aluminum/black mulching produced the higher fruit weight with 5.8 Kg. The higher yields per plot were obtained with the mulchings aluminum/black and white with 195.7, and 198.7 Kg, respectively. The higher values in °Brix were obtained with the white and brown mulchings with 9.8°. The bare soil showed the lowest values in all variables studied. A slightly difference was obtained with the organic mulching in comparison to the bare soil. In conclusion, the color of plastic mulching affected the plant and yield components in watermelon; the fruit sugar content was similar in all the treatments. The mulching colors aluminum/black and White showed the best fresh fruit yields.

*Specified Source(s) of Funding:* Univ of Colima Mexico

Wednesday, August 4, 2010

Springs F & G

## Crop Physiology: Cross-Commodity 2

### (087) Hypobarica and Hypoxia Enhance Phytochemical Production of Lettuce Plants (*Lactuca sativa*) in NASA Advanced Life Support Systems (ALS)

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Growing plants for long-term spaceflight environments is essential for providing nutritional, physiological, environmental and psychological well-being of the astronauts. Plants will supplement oxygen, scrub CO<sub>2</sub>, purify water, and supply food. In addition, plants provide phytochemicals (bioprotectants) that safeguard astronauts from the ionizing cosmic radiation exposure during long-term habitation. There are important engineering and crop production advantages in growing plants under hypobaric (reduced atmospheric pressure) conditions for extraterrestrial base environments. However, hypobaric conditions can lead to hypoxic-stress (low-oxygen), affecting plant photosynthesis and growth. A goal of the research was to enhance production of bioprotectants via hypobaria and hypoxia without reduction of plant biomass. The companion paper reports on plant gas exchange and growth, while this paper elucidates the enhanced production of plant bioprotectants. Twenty-one day-old seedling lettuce plants (*Lactuca sativa* L. cv. Red Sails) were grown under variable total gas pressures [25 (hypobaria) and 101 kPa (ambient)] during 10-d studies with partial pressures of oxygen (pO<sub>2</sub>) at: 101/21 (ambient), 101/6 (hypoxia), 25/12, and 25/6 (hypoxia) pO<sub>2</sub>; two other treatments included exposing plants to 101/21 or 25/12 for 7-d, then to hypoxia (101/6 or 25/6) during the final 3-d of production. In general, hypobaria in combination with hypoxia (during the final 3-d of production) enhanced the antioxidant activity (ORAC-value) of lettuce by stimulating the greatest synthesis of anthocyanins, total phenolics, chlorophyll a, chlorophyll b, and total carotenoids. While a 10-d exposure to hypoxia decreased biomass production (regardless of total atmospheric pressure)—there was no affect on chlorophyll or total carotenoid biosynthesis of ambient total pressure plants, while there was a reduction in hypobaric plants. Hypobaria enhanced chlorophyll and total carotenoids synthesis. The results show that bioprotectants can be increased by exposing hypobaric plants to hypoxia during the end of the production cycle, without loss of biomass.

Specified Source(s) of Funding: NASA

### (088) Effect of GA<sub>3</sub> and Ethephon on Photosynthesis of Wild *Rhododendron delavayi* Franch

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Flowering and growth of wild populations of *Rhododendron delavayi* Franch. could be regulated using GA<sub>3</sub> and ethephon. To better understand their effect, diurnal photosynthesis was monitored using portable LI-6400 photosynthesis system. The photosynthetic active radiations at the site were between 127.4 and 1257.3  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  and the temperatures ranged from 16.3 to 27.4 °C. Ambient CO<sub>2</sub> concentrations were 307.1–390.4  $\mu\text{mol}\cdot\text{mol}^{-1}$  and the relative humidity was 80.3% at 7:30 AM. The results indicated that both GA<sub>3</sub> and ethephon did not alternate the trend of diurnal photosynthesis rates. Under the treatments of 100, 200 mg·L<sup>-1</sup> and control (just pure water), the first peak rates were 11.60, 10.1, 8.29  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  of CO<sub>2</sub> at 11:30 AM and the 2nd peak rates were 9.41, 9.42, 7.42  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  of CO<sub>2</sub> at 3:30 PM, respectively. However, ethephon treatments reduced the photosynthesis rates. As ethephon concentration increased from 100 to 200 mg·L<sup>-1</sup>, the photosynthesis rate was much lower. Transpiration rate showed similar trend as the photosynthesis rate under all treatments. But, the highest rate, 4.62 mmol·m<sup>-2</sup>·s<sup>-1</sup> of H<sub>2</sub>O, occurred under the treatment of GA<sub>3</sub> 200 mg·L<sup>-1</sup> at 1:30 PM. Compared with the control, plants sprayed with GA<sub>3</sub> at 100 mg·L<sup>-1</sup> increased water use efficiency (WUE), while reduced WUE at GA<sub>3</sub> 200 mg·L<sup>-1</sup>. Stomata conductance and stomata limitation followed the same trend as the photosynthesis rates. When spraying GA<sub>3</sub> on *Rh. delavayi*, intercellular CO<sub>2</sub> concentrations (C<sub>i</sub>) reduced. If ethephon was applied, C<sub>i</sub> was higher than that of the control. It is possible that GA<sub>3</sub> could improve the photosynthesis rates because GA<sub>3</sub> regulated stomata function. Further studies are needed to address how did application of ethephon reduce the photosynthesis rates of *Rh. delavayi*.

### (089) Nutritional Quality and Chemical Characteristics in *Citrus sinensis* (L.) Osbeck Sweet Oranges from Northern Italy (Piedmont)

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In the North of Italy, Piedmont region (46°1'26.04"N; 8°41'13.92"E), there has been a historic tradition of citriculture since the 17th century, thanks to a favourable microclimate due to the presence of Maggiore Lake. Fifteen accessions of *Citrus sinensis* were grouped into three morphological traits (IPGRI Descriptor for *Citrus*): pigmented, navel and common oranges. Fruit from 5 trees within each group were analyzed for health and eating quality during the 2009–10 season: titratable acidity (TA), pH, total soluble solids (TSS), total phenolic content (TPC), antioxidant activities, vitamin C, hesperidin and narirutin contents. Spectrophotometric (ferric reducing antioxidant power and Folin Ciocalteu methods) and HPLC techniques were used. The antioxidant activity tested on orange juices ranged from 8.5 to 18.6 mmol Fe<sup>2+</sup>/kg FW; the TPC values ranged from 81.1 to 160.8 mg/100 g FW and the vitamin c content from 32.9 to 72 mg/100 mL. Hesperidin content ranged from 15.60 to 36.90 mg/100 mL and narirutin from 14.67 mg/100 mL to 35.20 mg/100 mL. Analyses of variance (ANOVA) for means comparison and HSD Tukey multiple range showed statistical differences between the three groups. This is the first report of screening for quality characterization, quantification of polyphenols and antioxidant activity on orange fruit juice grown in an area far away the traditional area of cultivation. The results were compared with bibliographic data about commercial varieties of *C. sinensis* from mediterranean and subtropical areas and showed that oranges grown in the North of Italy have reasonable qualitative characteristics and good nutritional properties.

### (090) Patterns of Nutrient Accumulation in 'Hass' Avocado Fruits

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'Hass' avocado trees absorb nutrients in relation to key stages of tree phenology. An understanding of the tree's seasonal nutrient requirements is critical for developing best management fertilizer practices. Nutrient analyses of developing 'Hass' avocado fruit collected monthly provided evidence that fruit accumulated all nutrients studied, except calcium (Ca), in a double sigmoid curve representing uptake during the summer and the following spring, with only limited accumulation during the winter months. The accumulation patterns, however, differed among nutrients. For example, nitrogen (N) and phosphorus (P) accumulation paralleled fruit dry matter accumulation, with about 50% of the total fruit N and P taken up by young fruit from mid-May through November and the remaining 50% taken up by mature fruit from April to July the following year. In contrast, approx. 30% of the total fruit potassium (K) concentration accumulated between mid-May to November, whereas the remaining 70% of

fruit K accumulated the following year between April and July. Fruit Ca concentration followed a single sigmoid accumulation pattern, initiated at full bloom, proceeding over the next 5 months and then remaining static through legal maturity and harvest. The results were used to time fertilizer applications to coincide with periods of fruit nutrient demand to improve nutrient uptake and reduce the potential for groundwater pollution.

Specified Source(s) of Funding: own

### (091) Testing a Tree Phenology Model to Predict Cherry Flowering Time at Select Locations in the United States

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The phenology of plants is sensitive to changes in temperature. During the past decades, considerable shifts in tree phenology have been reported in the temperate regions; these shifts are likely to be a response to the changing climate. Cherry trees are a good indicator of the impact of climate change on phenology because their flowering time is highly dependent on winter and early spring temperatures. The blossom of some cherry species (e.g., *Prunus serrulata*, *Prunus xyedoensis*) is celebrated with festivities in many parts of the world including the US, Japan, and Korea. For these reasons, the timing of cherry blossom engenders strong public interests and cultural attentions each year. Previously, we have shown that a thermal-time based two-step phenology model successfully predicted flowering time of *P. serrulata* throughout Korea. In this work, we calibrate the model for *P. xyedoensis* and test its applicability to predict cherry flowering dates in select locations in the US: Tidal Basin, Washington DC, and Seattle, WA. We then apply the model to predict future flowering dates in these areas based on the projected climate data up to year 2100. We discuss the implications of the model predictions and potential applications of the model.

Specified Source(s) of Funding: National Center for Agro-Meteorology, Korea

### (092) Nitrogen Metabolism of 'Gala' Apple Fruit in Response to Nitrogen Supply

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Amino acid profiles and activities of several key enzymes in nitrogen and amino acid metabolism in 'Gala' apple fruit were determined to understand how nitrogen metabolism in apple fruit responds to N supply. Seven-year-old 'Gala'/M.26 trees were grown in sand culture and provided with a total of 8.8, 26.4, 52.7 or 105.4 g actual N per tree from early May to harvest via fertigation in Hoagland's solution. As N supply increased, fruit N concentration at harvest increased linearly whereas leaf N concentration at regular leaf sampling time showed a curvilinear increase. Concentrations of soluble proteins, total free amino acids, and the proportion of total free amino acids accounted for by asparagine (Asn) in fruit increased with increasing N supply throughout fruit development. At harvest, fruit Asn concentration showed a linear response to N supply, and the increase was about 10 times more sensitive than fruit N concentration. The elevated Asn level at higher N supply corresponded with higher asparagine synthase activity, and may also be related to the enhanced transport of Asn into fruit. As N supply increased, glutamine synthetase, NADH-glutamate synthase, glutamate oxaloacetate transaminase (GOT) and glutamate pyruvate transaminase increased whereas glutamate dehydrogenase decreased, all of which contributed to the increased free amino acids in fruit tissue. GOT activity increased during fruit growth and in response to N supply, which paralleled with developmental increases and N-effected increases of some aspartate family amino acids such as aspartate and isoleucine, and threonine, confirming that GOT plays an important role in the synthesis of aspartate family amino acids. These results indicate that amino acid metabolism in apple fruit is up-regulated in response to increasing N supply and asparagine may serve as a sensitive indicator of fruit N status.

### (093) Effect of Blossom Thinning on 'Ambrosia' and 'Aurora Golden Gala' Apples

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Ambrosia and Aurora Golden Gala are two new apple cultivars with outstanding consumer acceptance, but in some years, fruit size has been smaller than desired by wholesale fruit buyers. Our objective was to assess the effectiveness of blossom thinning treatments for reducing initial fruit set and increasing final fruit size. The treatments were: fish oil and lime sulfur (2 + 2% v/v) at 20% and 80% bloom; aminothiosulfate (ATS, 1.6% v/v) at 20% and 80% bloom; hand blossom thinning, leaving only the king flower in each cluster, with clusters 10-15 cm apart; no blossom thinning. The treatments were applied in two consecutive years to mature trees trained as superspindles in a commercial orchard in Summerland, BC, Canada. Follow-up thinning of fruitlets was done by hand at the time of June drop.

The following data were recorded: time required to hand blossom thin; initial fruit set and cluster size distribution; time required for follow-up hand thinning of fruitlets; final crop load; yield per tree; average fruit weight; fruit box size distribution; return bloom. Return bloom in 2009 was satisfactory for all trees. Both chemical thinners were effective at reducing initial fruit set, but neither achieved the same reduction in set as blossom thinning by hand, and neither chemical eliminated the need for follow-up fruitlet thinning. Fruit box size distribution was best for the hand blossom thinning treatment in both cultivars. For Ambrosia, the ATS treatment produced a slightly more favorable fruit box size distribution than the fish oil + lime sulfur, but for Aurora Golden Gala, the opposite was true.

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Springs F & G

### Fruit/Nut 2

### (268) Fruit and Leaf Characteristics of 'Granny Smith' Apple Trees as Affected by Early Shading

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Shade nets can be an effective option to protect fruit trees from hail and sunburn, which have increased as a consequence of climate change. The effects of early shading on fruit and leaf characteristics of *Malus domestica* Borkh cv. 'Granny Smith' on MM.111 rootstock were evaluated in the High Valley region, Río Negro, Argentina. The trees were planted in 1988, trained to palmette leader, spaced 4.0 × 3.0 m and grown in sandy loam, at the orchard of the Comahue National Univ (lat. 38°56' S, long. 67°59' W). Row orientation was north-south. The experimental site was located in an arid region, with average annual rainfall of 250 mm. Relative humidity, sunshine duration and temperature were continuously monitored. Treatments were: a) application of shade, by covering individual branches with an 80 % black shade net, from 35 to 56 days after full bloom (DAFB), and b) control. Full bloom occurred on 2 October 2009. Fruit diameter (FD) was measured at two-weekly intervals. Additionally, fruit weight (FW), leaf area (LA), specific leaf weight (SLW), and chlorophyll content (CC) were determined at 56 DAFB. LA and CC were measured with a Cid - 202 leaf area meter and a Minolta SPAD - 502 portable apparatus, respectively. Means were compared using Student's t-test to determine significant differences ( $P \leq 0.05$ ). Regression models were estimated using the Statistical Analysis System software. Lineal models best fit

fruit growth and substantial differences were found between treatments: a)  $FD = 0.8093 \text{ DAFB} - 4.6037$ ,  $R^2 = 0.81$  ( $n = 264$ ), and b)  $FD = 0.6528 \text{ DAFB} + 0.1672$ ,  $R^2 = 0.77$  ( $n = 254$ ). Light reduction decreased FD by 7.57 % and FW by 21.2 %, as compared to the control. However, under the same conditions, LA, SLW and CC were not affected: 32.1 vs. 34.4 cm<sup>2</sup>, 5.11 vs. 6.19 mg/cm<sup>2</sup>, and 39.2 vs. 39.0 SPAD values for treatments a) and b), respectively. Further studies are needed to determine how shade conditions affect vegetative and reproductive growth of ‘Granny Smith’ apple trees.

Specified Source(s) of Funding: Comahue National Univ, Argentina

### **(269) Variability in Sweet Cherry Fruit Quality Is Related to Day of Anthesis**

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The high fruit-to-leaf area ratios and yields possible in modern, high-density sweet cherry orchards based on size-controlling rootstocks make thinning a necessity in most years. While there are no commercially proven thinning programs for sweet cherry, research is investigating blossom thinning with caustics, as in other tree fruit crops. In other tree fruit crops, early thinning is optimal, with the best results from thinning before or during bloom. Towards developing precision thinning strategies we initiated research to identify the relationship between timing of flowering and fruit quality potential. During the 2009 season, individual flowers of 2 replicate limbs of ‘Bing’ and ‘Chelan’ cultivars, and 3 replicate limbs of ‘Attika’ were labeled on their date of opening. In total, 2,599 flowers were labeled. From these flowers, 488 fruit were set, a yield of 18.8 %. Within each cultivar, all fruit were harvested on the same day and analyzed individually for standard quality parameters. ‘Bing’ bloomed over 13 days. Flowers that bloomed on the first, 7th, and 13th days yielded fruit with a mean weight of  $9.44 \pm 0.83$  g,  $7.02 \pm 0.71$  g, and  $5.30 \pm 0.90$  g, respectively. ‘Attika’ also bloomed over 13 days. Flowers that bloomed on the first day produced fruit with a mean weight of  $9.53 \pm 0.63$  g. The smallest fruit were produced by flowers blooming on the 11th day, producing fruit weighing  $7.60 \pm 0.93$  g. ‘Chelan’ had the shortest bloom period of the three cultivars, lasting only 10 days. Flowers that bloomed on the first day produced fruit with a mean weight of  $6.58 \pm 1.17$  g. Flowers from the 7th day of bloom produced the smallest fruit for this cultivar with a mean weight of  $4.68 \pm 1.06$  g. For each cultivar, we recorded significant differences in key fruit quality attributes related to flowering date. This research shows that on unthinned trees, there is greater fruit quality potential in the earliest opening flowers. Current research is investigating the role of crop density on the relationship between time of anthesis and quality potential.

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

### **(270) The Carbon Footprint of Cherry and Apple Orchards in Michigan: An Allometric Study to Support Early Development of a Carbon Sequestration Model**

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Currently the apple and cherry industries have been approached by the Delta Institute (<http://delta-institute.org>) to consider if these commodities might be interested in trading carbon credits on the CCX®. However, carbon sequestration figures do not exist for Michigan orchards, and would be at best estimates. A realistic estimate for these parameters is needed. Although the carbon footprint in an orchard accounts for alleys, weeds and soil management and fuel consumptions we are currently focusing on defining the carbon budget for apple and cherry trees. The model for apple carbon balance developed by Lakso et al. (2001) was adapted to Michigan climatic conditions to estimate the yearly carbon sequestration in standing biomass of apple orchards. The model component regarding assimilation rates was also modified to predict the seasonal photosynthesis and dry matter production for cherry. To validate the predictions for cherry, a dry matter study was conducted during the fall 2009. We measured the total biomass in the perennial structures of cherry trees excavated from two differently aged orchards (9 and 20 years). Trunk diameter was measured for each tree. Fresh weight of roots, trunks and branches was recorded in the field after the excavation. Subsamples were collected, weighted and dried to constant weight at 60 °C. In the 20 years old cherry trees study, several branches per tree were also subdivided according to the year of growth (2009, ‘08, ‘07 and older) and wood was weighted separately. The dry matter percentage in the wood of different years was not significantly different (mean = 62%). A regression analysis was performed on the data collected, correlating trunk circumference to root, trunk and branches dry weights. Slopes of the regressions from the two groups of trees used were not significantly different. The total aboveground biomass followed the regression equation ( $R^2=0.92$ ):  $y = 2.07x - 51.33$  where  $x$ = trunk circumference (cm) and  $y$ = aboveground dry biomass (kg). According to this study cherry orchards are able to sequester 0.48 tons of carbon per acre (considering 55% of carbon in dry wood). The model predicted 0.62 tons/acre for cherry and 0.59 tons/acre for apple. We are currently validating the percentage of carbon in dry wood. Although both the approaches support a positive carbon balance for apple and cherry production, we are planning to conduct a dry matter study in apple, and we are currently working on the further improvement of the cherry carbon model.

### **(271) Uncertainty Analysis of Visual Estimations of Apple Blush Coverage Compared to Digital Image Analysis**

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Estimates of the extent of coverage of red blush on apple surface play a role in the evaluation of apple strains, varieties, and horticultural practices. These estimates, however, may be subject to differences in ability or skill of observers. As such, they are data of unknown quality. This study was designed to quantify the uncertainty in visual apple blush estimates of 12 strains of Honeycrisp by trained observers, by comparing their estimates to output from digital image analysis (DIA) techniques. Experts were surveyed with images of apples displaying partial blush and asked to choose black/white representations of the blush. Preferred representations of the blush/non-blush threshold for Honeycrisp apples approximated a hue value 56 in CIELUV L\*C\*h color space. Using this threshold and two others representing the approximate bounds of expert opinion, about 3000 images of Honeycrisp apples harvested in 2009, taken with two digital cameras under controlled lighting and camera settings, were analyzed. The images were processed with color management techniques and cross-referenced with standard color chips photographed in the light box and with output from a CM2600d Minolta spectrophotometer used to measure the color chips and selected apples. Pixels in each image were categorized as blush, non-blush, and background. The background was ignored and percentage blush was calculated for each image. Frequency distribution curves of percentage blush were prepared for each of the blush threshold values examined -- the preferred value, the lower bound, and the upper bound. Percentage blush as a function of frequency distribution approximated the exponential recovery function, indicating a strong tendency toward higher blush for the 2009 season. Experts were asked to rate the percentage blush of 99 images of these apples, representing 9 randomized replications of each of 11 blush percentage classes. Experts estimated blush in close correspondence to DIA ( $R^2=0.96$ ), but showed slight systematic bias. DIA proved to be a viable methodology for examining large volumes of photographic data accurately, with higher consistency than human judgment, and with minimal effort. The authors wrote two macros in the open-source software package ImageJ and have made them available to the research public. The first macro is an apple isolator that modifies a digital image of an apple by removing the background (low saturation) portion of the image. The second macro calculates percentage blush of an image of an apple using a threshold hue value specified by the user.

Specified Source(s) of Funding: USDA, SCRI, Comprehensive Automation for Specialty Crops

### **(272) An Automated Digital Image Analysis Technique for Quantifying Apple Blush Coverage**

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Estimation of red blush coverage extent is important in evaluation of apple appearance. USDA grading standards, for example, specify percentages of blush coverage necessary to meet three grades for several varieties. Also, consumer choice is influenced by blush as it informs visual estimations of expected fruit quality. Researchers and industry professionals have conventionally relied on visual estimates of blush by trained observers. These estimates, however, may be subject to differences in skill and may not always be consistently applied. We present an alternative method for quantifying blush, applying image analysis techniques to digital photographs. About 3,000 images of Honeycrisp apples from the 2009 growing season were photographed under a variety of conditions and analyzed. Issues in color accuracy, image consistency, automation of analysis using macros in Java (ImageJ), lighting, and camera operation were explored. The resulting method consists of a process to create accurate blush estimates for digital images of apples. The first step is instrument calibration. This includes building a light booth appropriate for apple images, establishing camera settings appropriate for light conditions, and analyzing the error of camera output by comparing red-green-blue values from images of captured reference color chips to published values and to the output of spectrophotometer measurements. Once the error is understood, appropriate linear transforms for RGB vectors can be applied to output images for data correction. Once the accuracy and reliability of the system has been maximized, images of the apples are taken in the light booth. Images are pre-processed to remove the image background by re-assigning the values of pixels with saturation below a given threshold to null. Another threshold is then applied to the resulting image in order to establish the hue boundary between blush and non-blush pixels. Images are then reclassified to values representing colors below the blush threshold, above the blush threshold, and null values for non-apple pixels. Analysis consists of analyzing pixels classified as blush and non-blush, and calculating the prevalence of each class to the whole. The process is then automated so that the pre-processing and classification steps are expressed in two Java macros that can be automatically applied to all images in a given directory in a matter of minutes. The Java macros operate within the open-source free software program ImageJ, available from the National Institutes of Health. The authors will also make the apple-blush-analysis macros freely available to the public.

Specified Source(s) of Funding: USDA, SCRI, Comprehensive Automation for Specialty Crops



**(273) Apple Cropload Adjustment with the Equilifruit Disk**

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Cropload adjustment via hand thinning is an effective means of increasing apple (*Malus ×domestica*) fruit size. Unfortunately, reductions in yield can occur with excessive thinning. Growers utilize a variety of untested hand thinning heuristics to adjust final cropload after inadequate chemical thinning. The Equilifruit disk, which was developed by the National Institute for Agricultural Research (INRA) in France, is a handheld tool that measures the fruiting branch cross-sectional area (FBCSA) and gives an estimate of the number of fruit that can best be supported. The accuracy and efficacy of the Equilifruit Disk was evaluated in the summer of 2009 at the Penn State Fruit Research and Extension Center in Biglerville, PA. A randomized block experiment with five replications was performed on 6th leaf 'Golden Delicious' trees on Budagovski 9 rootstock. Despite two post-bloom applications of chemical thinners, hand thinning was necessary to optimize fruit size. Treatments were applied as follows: 1) no additional thinning (control), 2) hand thinned using the Equilifruit disk, and 3) hand thinned using a spacing heuristic of 7-8 inches between solitary fruits. All treatments and measurements were conducted after the June drop. The treatments were compared by crop density (number of fruits per square centimeter of trunk cross-sectional area (TCSA)), yield efficiency (yield/TCSA), total yield, and fruit size distribution. The crop densities for each treatment were as follows: Control: 10.50 fruit/cm<sup>2</sup>; Equilifruit: 8.40 fruit/cm<sup>2</sup>; and the heuristic: 6.29 fruit/cm<sup>2</sup>. Yield efficiency of the control and Equilifruit were similar; 1.82 and 1.78 kg/cm<sup>2</sup> TCSA respectively, while the spacing heuristic was 1.49 kg/cm<sup>2</sup> TCSA. Both the Equilifruit and the heuristic were effective in creating an upward shift in the fruit size distribution, however; the heuristic reduced yield by 5.40 kg per tree. The heuristic had the highest yield per tree of fruit greater than 76 mm (8.19 kg), followed by the Equilifruit (6.44 kg), and the control (2.76 kg). The results of this experiment indicate that the use of the Equilifruit disk has potential to increase fruit size in 'Golden Delicious' while maintaining yield. The Equilifruit disk can be used to train employees in hand thinning practices, and may be incorporated into future selective thinning technologies. Future studies are planned on small fruited cultivars such as 'Gala', and biennial cultivars, such as 'HoneyCrisp' and 'Fuji'.

Specified Source(s) of Funding: USDA, SCRI, Innovative Thinning of Fruit

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Springs F &amp; G

**Genetics/Germplasm/Plant Breeding: Biotechnology 1****(057) Stress Tolerance of Transgenic Tomato Overexpressing a Germin Gene**

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In our completed studies, tomato plants reduced expression at transcript and protein levels oxalate oxidase under aluminum stress, but increased expression of the same gene under salt treatment. To understand function of oxalate oxidase in different types of abiotic stresses, a germin gene encoding for oxalate oxidase was transformed into tomato cv. Money Maker. After five generations of self pollination, homozygous transgenic lines were obtained. These transgenic lines were confirmed by herbicide resistance which is conferred by bar gene, and PCR analysis using the gene-specific primer pair. The enzyme activity of the oxalate oxidase was significantly higher in transgenic plants than nontransgenic plants. Tolerance to Al and salt stress of the transgenic tomato plants was evaluated based on physiological and phenotypic properties. The effect of overexpression of the foreign germin gene on whole genome expression in transgenic tomato were studied using microarray and proteomics analysis in order to determine the affected metabolic pathways.

Specified Source(s) of Funding: USDA Evan Alen funds

**(058) Transformation of Poplar Tree with CMO and BADH Genes for Enhancing Tolerance to High Soil Salinity**

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Choline monooxygenase (CMO) and betaine aldehyde dehydrogenase (BADH) are two enzymes that control synthesis of glycine betaine (GB) in plants. Glycine betaine is an osmoprotectant for maintaining osmotic balance of cells. Research confirmed that exogenous application of GB enhances tolerance of GB non-accumulating plants to abiotic stresses, such as soil salinity, drought, and low temperature. CMO and BADH genes were individually cloned from *Suaeda salsa*, a plant grown in the extremely high salt soil and fused together using oligopeptide 2A region from foot-and-mouth disease virus (FMDV). The fused gene (C2AB) successfully co-expressed in yeast and their activities were >40-fold higher than those in the control. In this study, *Agrobacterium tumefaciens* strain EHA105 that harbored a binary vector (pCAMBIAS1300 and its T-DNA region co-expressing betaine synthase genes) was used to transform an aspen hybrid (*Populus × canescens* × *P. grandidentata*). Transformation was primarily confirmed by polymerase chain reaction (PCR). The expression of C2AB fused gene in aspen plants was confirmed using RT-PCR. These transgenic lines are being cloned in vitro and will be further evaluated for salt tolerance under both in vitro and ex vitro conditions. This research shows a great potential to improve abiotic stress tolerance of poplar, an important tree species for the forestry industry and biomass production.

Specified Source(s) of Funding: CPBR

### (059) The Effect of Environment on Transgene Evaluation

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Many genetically engineered crops now in development aim to combat abiotic stresses that reduce yield worldwide. Numerous kinds of genes, including regulatory and metabolic genes, have potential for increasing abiotic stress tolerance. These genes confer more complex traits than currently commercialized transgenes and are more likely to increase secondary effects of transgene expression. To better understand secondary effects important for risk assessment, we studied three transgenes that increase salinity tolerance by differing mechanisms in the model species *Arabidopsis thaliana*. Salt Overly-Sensitive 1 (SOS1) encodes a plasma membrane Na<sup>+</sup>/H<sup>+</sup> antiporter, mannose-6-phosphate reductase (M6PR) encodes a mannitol biosynthesis enzyme, and C-repeat binding factor 3/drought responsive element binding factor 1a (CBF3/DREB1a) encodes a transcrip-

tion factor for abiotic stress gene regulation. Transgenic plants were grown in the field in spring, summer and fall seasons for multiple generations and monitored for survival, seed yield and viability, traits vital to long term population survival and competition. Relative transgene fitness effects were calculated by comparisons of transgenic versus wild-type (WT) frequency by selectable marker screening of successive progeny from fourteen replicate mixed populations per transgenic line. Seed yield comparisons also were made between pure populations of WT and transgenic lines (5 reps/line). Regardless of season CBF3 expression delayed development, while M6PR and SOS1 lines were unaffected ( $P < 0.013$ ,  $P > 0.8$ ). The fall season slowed development for all lines (all  $P < 0.001$ ). Plant survival to seed set was unaffected by transgene expression, but was influenced by season, lowest in fall and highest in spring ( $P > 0.7$ ,  $P < 0.02$ ). Both seed yield and biomass were affected by season, highest in spring and lowest in fall ( $P < 0.02$ ). Averaged across seasons, harvest index was unaffected by CBF3 and SOS1, but was increased by M6PR ( $P > 0.16$ ,  $P < 0.03$ ). M6PR lines had the highest overall fitness relative to WT ( $P < 0.001$ ). M6PR and CBF3 fitness was highest in fall, while SOS1 remained constant across seasons ( $P < 0.001$ ,  $P < 0.001$ ,  $P > 0.99$ ). M6PR and CBF3 had genotype x environment interactions, with M6PR fitness above wild-type summer and fall but equal to WT in spring, while CBF3 fitness was well below WT in spring and summer, and equal to WT in the fall ( $P < 0.01$ ,  $P < 0.02$ ). Thus, transgenic plant productivity and fitness varied by environment with a variety of interactions between different transgenes and the environment. These results indicate the importance of considering environmental influences during the risk assessment process for transgenic crops altered to increase abiotic stress tolerance.

### (060) Molecular Characterization of the IRT Gene Family in Poplar (*Populus tremula* 'Erecta')

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Iron chlorosis, a common problem in plants grown in the alkaline/calcareous soils, causes yield loss, reduces fruit quality, and destroys aesthetic beauty of plants. Research has verified that iron chlorosis is not directly related to the supply of iron in the soil, but related to the plant's ability to acquire iron from the soil and to efficiently transport iron in plants. It was demonstrated that iron transport is controlled by a series of iron-regulator transporter genes (IRT). The IRT genes encode iron transporter protein to transport Fe (II) from the root to the leaf where iron is used for synthesis of chlorophyll. In this study, 18 IRT sequences were selected from the genome sequence database of *Populus trichocarpa* based on the conserved ZIP family domain derived from *Arabidopsis* AtIRT1 gene. Using homology cloning strategy, candidate genes were amplified from two phenotypes of *Populus tremula* 'Erecta'. One phenotype (wild type) has

the classic iron chlorosis symptom (bright yellow leaf with green veins) and the other shows tolerance to iron-deficiency (mutant) under the same soil condition. To date, one candidate gene (PtIRT1) was isolated from the genomic DNA of 'Erecta'. This PtIRT1 gene is composed of two introns and three exons. Putative protein structure analysis showed that the PtIRT1 gene contains the conserved ZIP family domain and a signal peptide, suggesting that the PtIRT1 gene has the same gene structure and functional domain as AtIRT1 and AtIRT2 genes. Compared with the IRT genes of other species, the PtIRT1 has 64% homology with the AtIRT1 and 77% with the OsIRT1. Expression analysis showed that the PtIRT1 gene did not express in young leaves of 'Erecta'. Putative protein sequence alignment of the PtIRT1 gene of the wild type to that of the mutant showed that these two genes share 98.05% identity. Hydrophobicity and hydrophilicity analyses indicated that six different regions corresponding to the different amino acid regions in the two PtIRT1 genes were observed. This research will help understand mechanisms of iron uptake and utilization and address iron chlorosis in plants, particularly in woody species in the alkaline/calcareous and waterlogged soils.

### **(061) Variation in Anthocyanins in Blueberry (*Vaccinium* spp.) and Implications for Human Health and Genetics Research**

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This study was conducted to characterize phytochemicals with human health benefits in a range of varieties and populations of blueberry (*Vaccinium* spp.). A total of 200 genotypes which had been bearing blueberry fruit for 3 years were established in Piedmont Research Station, Salisbury, NC. These genotypes represented multiple ploidy levels of blueberry species including *V. elliotii*, *V. pallidum*, *V. virgatum*, *V. tenellum*, *V. corymbosum*,

and *V. stamineum*. Cultivars included O'Neal, Arlen, Sampson, Legacy, and Pamlico, and several-interspecific crosses. Samples (200 g, ripe fruits) were harvested in July 2009 when 75% of the fruits had changed color. A representative sample of 20 g frozen fruits for each genotype was extracted and profiled for anthocyanins. The assayed blueberries mainly contained 17 major anthocyanins, and included glycosidic forms of delphinidin, cyanidin, petunidin, peonidin, and malvidin. Significant variation in anthocyanin profile and concentration was found among blueberry genotypes. Total anthocyanins in fresh fruits ranged from 1.2mg/g to 2.8mg/g. However, although some genotypes contained similar anthocyanin concentrations, the detailed HPLC-MS analysis revealed different profiles in the number and type of anthocyanins accumulated in each genotype. The implications for bioactivity testing for human chronic diseases and the gene or single nucleotide polymorphisms (SNPs) discovery and application into the molecular genetics and breeding for lines with specific anthocyanin profiles are discussed.

Specified Source(s) of Funding: NCSU

### **(062) Production of Marker-free Transgenic Lettuce with Resistance to Mirafiori Lettuce Big-vein Virus**

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Lettuce big-vein disease, which is found in major lettuce production areas worldwide, is caused by Mirafiori lettuce big-vein virus (MLBVV). In order to produce marker-free transgenic lettuce resistant to MLBVV, we constructed a two T-DNA binary vector in which the first T-DNA contained a selectable marker gene npt II (neomycin phosphotransferase II) and the second T-DNA contained polyubiquitin gene promoter/terminator and inverted repeats of the viral coat protein (CP) gene. These T-DNAs were transferred via *Agrobacterium tumefaciens* (LBA4404)-mediated transformation into a lettuce cultivar 'Watson'. About 40% of regenerated plants (T0 generation) on kanamycin medium showed CP gene-positive by PCR analysis. CP gene-positive plants were self-pollinated, and 124 T1 lines were analyzed for resistance to MLBVV. Twenty-one lines were selected as resistant

to MLBVV, and 5 of 21 lines contained npt II-negative plants. Npt II-negative plants were self-pollinated, and 5 T2 lines were analyzed for resistance to MLBVV. All lines showed resistance to MLBVV, but one line showed npt II-positive by PCR analysis (selection error in T1 generation). The other 4 lines showed npt II-negative by both PCR and Southern blot analysis. Southern blot analysis showed that 2 of 4 lines contained one copy of the transgene per genome and that the other 2 lines contained more than one copy.

Specified Source(s) of Funding: National Agriculture and Food Research Organization (NARO), Japan

**(063) Expression and Establishment of the Optimum Conditions for the Mass Production of the Biochemically Active Human Tissue-plasminogen Activator in Hairy Roots of *Cucumis melo* (Oriental Melon)**

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Human tissue-plasminogen activator (t-PA), its derivatives and synthetic genes were expressed as enzymatically active form from hairy roots of *Cucumis melo* L. cv. Geumssaragi-euncheon (Oriental melon) infected by *Agrobacterium rhizogenes* strains K599 harboring binary vectors. The insertion of the t-PA genes in genomic DNA of transgenic hairy roots was verified by PCR. The presence of the t-PA-specific transcripts in the total RNAs of transgenic hairy roots was confirmed by RT-PCR. Western blot analysis of the transgenic hairy roots showed a single major band of 68-kDa recombinant t-PAs. ELISA experiments demonstrated that the highest level of recombinant t-PA expression was average 0.03% of the total soluble protein in hairy roots transformed by plasmid p221t-PAer. The optimum condition for the growth of transgenic hairy roots were MS and WPM of optimal medium, 7.0 of pH level, sucrose of carbon source and 1% of sucrose concentration. After 14 days of inoculation the yield of hairy roots grown on MS medium (pH 7.0) was 18 times higher than that of the immediately inoculation. The yield of

hairy roots grown on MS medium was 618g at pH 7.0. These studies demonstrated that hairy roots could be employed for the mass production of an enzymatically active t-PA.

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Wednesday, August 4, 2010

Springs F & G

**Genetics/Germplasm/Plant Breeding: Fruit/Nut Crops 2**

**(024) Seedling Rootstock Recommendations for Pawpaw (*Asimina triloba*)**

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The pawpaw [*Asimina triloba* (L.) Dunal] is the largest tree fruit indigenous to the United States, and is commercially produced on a small scale as a niche fruit crop. Pawpaws cannot be successfully propagated via cuttings, layering, or tissue culture, and clonal rootstocks are not available for pawpaw cultivars. Therefore, cultivars are grafted onto seedling rootstock of diverse genetic origin. Great variation in tree survival, scion growth, and fruit production are often observed. Pawpaw rootstocks that are vigorous, have a high survival rate, and promote precocity and high fruit yields would be desirable to growers. A field study was conducted to determine if survival, growth rate of scions, and fruit yield would vary by seedling rootstock source. Scions of the pawpaw cultivars Susquehanna and Sunflower were grafted onto rootstock derived from seedlings of 'Sunflower', 'PA-Golden', 'Susquehanna', the selection K8-2, and commercially available mixed seed (RVT). The rootstock trial was planted in 2004 at the Kentucky State Univ Research Farm in a randomized complete block design. Seedling rootstock derived from 'Susquehanna' and K8-2 had survival rates below 60% and are not recommended for use as a rootstock source. Early fruiting data indicated an influence of rootstock on fruit weight. In 2009, rootstock influenced fruit weight, with trees on 'Sunflower' and 'PA-Golden'-derived rootstock producing larger fruit (226 and 235 g, respectively) than those on K8-2-derived seedling rootstock (176 g). Rootstock did not significantly influence trunk cross sectional area, number of flowers, fruit set, number of fruit, yield, or yield efficiency.

Specified Source(s) of Funding: Evans-Allen Project # KYX-10-09-44P

### **(025) Searching for the Next Pawpaw Cultivar: An Update on Germplasm Screening at Kentucky State University**

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The North American pawpaw [*Asimina triloba* (L.) Dunal] is a 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. New high yielding cultivars with excellent fruit quality would assist in the development of a pawpaw industry. Kentucky State Univ (KSU) serves as the National Clonal Germplasm Repository for pawpaw, and germplasm evaluation is an important research priority. The KSU selection K8-2 is a seedling from Maryland that has undergone evaluation at KSU over the last 10 years. This selection has been stably propagated via budding from the original K8-2 tree onto seedling rootstocks. Yield and fruiting characteristics of mature K8-2 trees were compared to commercially available pawpaw cultivars. In May of 2000, trees of K8-2, and the pawpaw cultivars 'PA-Golden' and 'Mitchell' were planted at the KSU Research and Demonstration Farm in three replicated blocks. Trunk cross-sectional area (TCA), yield, yield efficiency, and fruit weights were recorded in 2009. Tree size, as measured by TCA, was similar for trees of all cultivars. The selection K8-2 (33 kg), 'PA-Golden' (29 kg), and 'Mitchell' (29 kg) displayed similar yields per tree. Average fruit weight for K8-2 (109 g) was significantly greater than either 'PA-Golden' (79 g) or 'Mitchell' (64 g). The selection K8-2 is being released to the public. Additional pawpaw accessions have been selected for a regional trial in 2011 and will be discussed.

Specified Source(s) of Funding: Evans-Allen Funding

### **(026) Yield Characteristics from 2006 to 2009 for Primocane-fruited Blackberries from the University of Arkansas Breeding Program Grown in Kentucky**

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Primocane fruited blackberries are attractive to Kentucky growers because they have the potential to produce a niche-market crop from late summer until frost. The objective of this study was to determine if advanced selections developed by the Univ of Arkansas Blackberry Breeding Program were superior to Prime-Jim® and Prime-Jan® in terms of yield and fruit size under Kentucky growing conditions. In June 2006, six selections of primocane fruited blackberries from the Univ of Arkansas breeding program (APF-27, APF-40, APF-41, APF-42, APF-46, and APF-77), the commercially available primocane fruited cultivars Prime-Jim® and Prime-Jan®, and the florican fruited cultivar Chickasaw were established at the Kentucky State Univ Research Farm. In 2007, 2008, and 2009, primocane fruit production was evaluated for primocane fruited selections. Winter injury and late-spring frost damage limited florican fruit production in the 2007 and 2009 seasons. In 2007, the selection APF-40 had the greatest yield (2598 lbs/acre) with Prime-Jim® displaying the smallest yield (295 lbs/acre). Berry weight was significantly larger for the selections APF-40 and APF-41 (about 3.9 g/berry) than all other selections. In June 2008, APF-41 and APF-77 produced the largest florican crops of 4415 and 3717 lbs/acre, respectively, and APF-46 the smallest florican crop (672 lbs/acre). For the florican crop, APF-41 and APF-40 had the largest berries of all selections at 6.2 and 5.0 g, respectively. APF-27 had the largest primocane crop in 2008 (3005 lb/acre); this selection had an almost 2-fold increase in the yield of the previous year. Primocane production from APF-77 (2229 lbs/acre) also increased almost 2-fold in yield compared to the previous year's primocane crop. Although APF-41 had a large florican crop in 2008, the primocane crop was only about one-quarter the size of the florican crop and was about 60% that of the 2007 primocane crop. Primocane fruit of APF-41 were still large in size, but the primocane fruit of this selection were only 4.4 g on average compared to the 6.2 g on average for floricanes in 2008. Even with irrigation, summer drought conditions may have negatively impacted the primocane crop of all selections. In 2009, APF-77 had the highest primocane crop (4189 lbs/acre) and Prime-Jim® the lowest (1390 lbs/acre). APF-41 had the largest berry size (6.3 grams/berry) and Prime-Jim® the smallest (4.2 grams/berry). Several advanced selections appear to have superior production characteristics compared to Prime-Jan® and Prime-Jim® and are under consideration for release by the Univ of Arkansas.

### **(027) Using SSR Markers to Enhance Genetic Variation in the Development of Pawpaw (*Asimina triloba*) Cultivars**

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Pawpaw [*Asimina triloba* (L.) Dunal] is a tree fruit native to eastern North America which is in the early stages of domestication. Maintaining a high level of genetic diversity is important for the long-term genetic improvement of the crop, and in minimizing vulnerability to disease. Cultivars available in the early 20th century have been lost, and significant genetic erosion may have occurred. Recent pawpaw breeding efforts by the PawPaw Foundation (PPF) have yielded seven recent cultivar releases. These selections have shown some fungal (*Phyllosticta*) and pest (leaf roller, etc) susceptibility. Kentucky State Univ (KSU) has identified eight advanced selections that display high yields and excellent fruit quality. The objective of this study was to compare the genetic variation exhibited among old and new pawpaw cultivars and KSU advanced selections using simple sequence repeat (SSR) markers. Leaf samples were collected from older pawpaw cultivars (Middletown, NC-1, Overleese, Rebeccas Gold, Sweet Alice, Taylor, Taytwo, and Zimmerman), recently released PPF cultivars (Allegheny, Shenandoah, Susquehanna, Wabash, Rappahannock, and Potomac), and KSU advanced selections (G4-21, G4-25, G5-23, G5-29, G9-109, G9-111, H3-120, and G6-120) for DNA extraction. DNA samples were amplified and SSR-PCR products separated by fluorescent capillary electrophoresis. Twenty microsatellite loci were examined. Grouping of genotypes in an unweighted pair group method with arithmetic mean dendrogram showed that the PPF cultivars were more closely grouped with the older cultivars and that the KSU advanced selections group was genetically distinct from the older and PPF cultivars. If the KSU selections are released to the public, they would enhance the genetic variation of commercially available pawpaw cultivars.

Specified Source(s) of Funding: Evans-Allen Program Funding and USDA 1890 Institution Capacity Building Grants Program

### (028) Defining Pollen Flow Patterns in a Black Walnut (*Juglans nira* L.) Orchard in Missouri

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Apaternity analysis was conducted to increase our understanding of spatial pollen flow dynamics within black walnut orchards. Open pollinated seeds were collected from three 10-year-old ramets of the cultivar Sparrow growing in a clonal repository in central Missouri. This study orchard contained a total of 21 cultivars, each represented by two to four ramets. A total of 389 nuts derived from the 2006 seed year were genotyped using 11 microsatellite markers and compared to the genetic fingerprints of all potential pollen sources within the orchard to determine paternity. In addition, 191 wild trees growing within a radius of 500m of the study orchard were genotyped using 11 microsatellite markers to provide an estimate of potential pollen contamination. The number of pollen donors varied by ramet, and no dominant pollen source was identified. Rather, each ramet was associated with a different dominant pollen parent. Observed selfing rates ranged from 2.7 to 3.9%. Pollen contamination ranged from 45.7 to 59.3%, depending upon ramet. Spatially, the majority of contamination came from >500m, since only 6.0 to 14.9 percent of this outside pollen could be sourced to the 191 wild trees growing within 500m of the study orchard.

Specified Source(s) of Funding: USDA ARS

### (029) Release of Male Pistachio Cultivar 'Randy'

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'Randy' is a male pistachio (*Pistacia vera* L.) cultivar developed for pollination of the new female pistachio cultivars released by the California Agric. Expt. Station. 'Randy' usually flowers earlier than 'Kerman' and was developed as a pollinizer for the earlier flowering female cultivars, 'Golden Hills' and 'Lost Hills' (also released by the California Agric. Expt. Station. During years when 'Peters' pollen shed is later than 'Kerman's' receptive period, 'Randy' may be a useful pollinizer for 'Kerman' as well as in years when 'Kerman' has an irregular bloom period. 'Randy' flowers from four to eight days earlier than 'Peters', and like 'Peters', has an extended flowering period. It has flowered well and uniformly during low chill seasons in Kern Co. and

Madera Co., California. The pollen is durable, retaining viability for up to 28 days after shed. Initial pollen viability is also high compared to other potential pollenizers.

Specified Source(s) of Funding: former California Pistachio Commission

## Wednesday, August 4, 2010 Springs F & G Irrigation/Water Utilization

### (211) Effect of Irrigation Frequency on Arid-adapted Landscape Trees

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This ongoing research project addresses irrigation management of landscape trees in the low desert of Arizona. The objectives of the project are to determine how nine species of commonly used landscape trees will perform in Maricopa, Arizona with different irrigation frequencies. Irrigation is activated for each treatment when the soil moisture in the root zone is depleted by 30%, 50% or 70% based on the reference evaporation at the site. Trees were planted in January 2007 and irrigation treatments started in September 2008. Tree species used were: *Cupressus arizonica* (Arizona cypress), *Chilopsis linearis* 'Art's Seedless' (desert willow), *Ebanopsis ebano* (Texas ebony), *Fraxinus velutina* 'Rio Grande' (Rio Grande ash), *Parkinsonia thornless* hybrid (palo verde hybrid), *Pinus eldarica* (Afghan pine), *Pistacia* x 'Red Push' (Red Push pistachio), *Prosopis velutina* (velvet mesquite), and *Quercus virginiana* (Southern live oak). Plant height, canopy width, and caliper are measured twice a year and quality ratings are monitored on a monthly basis. Fastest growing plants were palo verde hybrids followed by mesquite with an intermediate growth rate and the slowest growing trees were Afghan pine and Texas ebony. Growth rates of the remaining trees ranged between the intermediate and slow growing ones. After 12 months of treatments no differences in height, caliper, or growth index were found when comparing irrigation treatments within each species except for desert willow and Afghan pine where trees receiving irrigation with the longest interval started to have smaller caliper than trees more frequently irrigated. However, trends are starting to emerge where some species receiving the least frequent amount of irrigation are starting to show signs of water stress. Leaf tip burns were observed through the summer and fall on desert willow and Arizona cypress. Overall quality of trees was good according to the monthly ratings with the

average ranging from 3.4 to 4.8 for all tree species since irrigation treatments started and no differences between treatments. The overall quality rating of 3 = medium quality and minimum acceptable appearance, 4 = high quality, good appearance, and 5 = outstanding quality and appearance. The number of irrigation events for the 30%, 50%, and 70% water deficit was 46, 30, and 20, respectively over a 12-month period. In summer, the shortest interval between irrigation events was 3, 4, and 8 days, and in winter the longest interval between irrigation events was 36, 60, and 68 days with increasing soil moisture deficit treatments.

Specified Source(s) of Funding: Bureau of Reclamation, TRIF, Arizona Landscape Contractors' Association

### (212) Creating a Landscape Water Budget Calculator for a Desert City

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New Mexico's most populous city, Albuquerque relies on ground water as the main source of water for irrigating urban landscapes. Albuquerque's annual rainfall is 226 mm (8.9 inches). The main source of water for the urban sector of Albuquerque is underground water. Albuquerque is likely to suffer water supply crises by 2025 because water extractions from underground aquifers exceed recharge rates. Knowledge of residential landscape water requirements has the potential to help residents use landscape irrigation more efficiently. The objective of this study was to create a scientifically-based water budget web interface for the desert city of Albuquerque. The web interface allows residents to estimate their monthly or yearly landscape water budget based on the landscaped area, areas of vegetation types, or landscape species composition. Residents are able to view their parcel property image and digitize water consumptive landscape features which are subsequently used to estimate water budgets. Length of growing season, annual temperature and growing degree days were used to transfer landscape plant coefficients from the California landscape irrigation guide and data from New Mexico State Univ. Water budget calculations can use either current (monthly) or historical (monthly and yearly) evapotranspiration values. In addition, monthly and yearly historical reference evapotranspiration values for El Niño,

La Niña and Neutral signals are available and allow the water budget to be modified based on the current year signal. This web interface may be used as a tool to conserve water in the desert city of Albuquerque because residents can use the web tool to determine their landscape irrigation needs. Also, municipalities can use the web tool as a planning interface to estimate water budget for new developments.

Specified Source(s) of Funding: NOAA

### (213) Developing Water Balances of Ornamental Landscapes

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Landscape irrigation represents a major portion of the potable water use in arid and semi-arid regions (30-70% in Intermountain West). Therefore, there is considerable potential for water savings through conservation in the landscape. Using plant species that require less water is one important principle of Xeriscaping™, but little research has been done to investigate the water requirements of water efficient landscapes differing only in plant materials. Nine landscapes were installed in large, drainage lysimeters with three classes of plant material: traditional (high water use), intermediate (moderate water use), and native/adapted plant species of the Intermountain West (low water use). Each plot was divided into three irrigation zones: shrub, turf and perennial. In each zone, 4 Acclima™ soil moisture sensors were installed at 80, 45, 20, and 5-cm depths. Sensors measured soil volumetric water content and electrical conductivity, representing soil layers between 100 to 60, 60 to 30, 30 to 10 and 10 to 0-cm, every hour. Three plots (one for each landscape type) were chosen as master plots, and sensors at different depths in each zone of master plots were used to control irrigation. Leachate from each landscape was quantified using dippers connected a Campbell Scientific™ CR1000 data logger. Water balances for each irrigation zone were developed using the water balance equation (Total ET= DW + Precipitation + Irrigation–Leachate), and allowed comparisons to be made of the water requirements of different plant materials in landscapes. Furthermore, water balances were developed for each plot to investigate the overall water requirements for the three landscape types.

### (214) Performance of Weather-based Residential Irrigation Controllers in a Desert Environment

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Weather-based irrigation controllers have the potential to conserve water. The objective of this research was to test the performance of five weather-based irrigation controllers and one user-controlled irrigation controller. The Rain Bird ET manager, Hunter ET system, Irritrol Smart Dial, Aqua Conserve (ET-6), Weathermatic (Smart Line), and the user-controlled Hunter Pro C controller were tested. The Hunter Pro C was manually programmed to irrigate at 80% of historical reference evapotranspiration. Controllers were connected to a sprinkler system that irrigated 3.6 by 3.6 m tall fescue (*Festuca arundinacea*) plots. The irrigation system was equipped with low flow electronic sensors connected to a datalogger. Controllers were field-tested in Las Cruces, New Mexico from the Dec. 15, 2009 to Jan. 31, 2010. During the experiment, there were six rainfall events that averaged 6.3 mm/event. The Irritrol Smart Dial applied 45 liters of water per square meter of turf and had an irrigation event every 16 days. Rain Bird ET manager applied 63 liters/m<sup>2</sup> had an irrigation event every eight days. Weathermatic (Smart Line) applied 92 liters/m<sup>2</sup> and had an irrigation event every seven days. The Hunter Pro C, Hunter ET system, and Aqua Conserve applied 95, 179, 248 liters/m<sup>2</sup>, respectively. While the Hunter Pro C had one irrigation event every seven days, the Hunter ET system irrigated every four days. The Aqua Conserve had an irrigation event almost daily. Although our preliminary results show that the Irritrol Smart Dial and Rain Bird ET manager applied the least water when compared to the user-set hunter controller, longer testing will be needed to gauge how well those controllers maintain turf quality.

Specified Source(s) of Funding: NOAA

### (215) Strawberry Establishment with Drip or Sprinkler Irrigation

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Strawberry, a major crop grown in Ventura County, California, has an annual value of \$394 million. Each September, 1.2 m-wide raised beds are constructed with two drip irrigation lines placed 5-10 cm deep and covered with polyethylene mulch. Narrow holes are cut into the mulch and by October, bare-root plants from high elevation nurseries are planted such that each drip line waters two rows of plants, one row on either side of the line. For the first 5-8 weeks after planting, however, overhead sprinkler irrigation in daily amounts ranging from 50-60 mm



is used instead of drip to rapidly hydrate plants, aid adventitious root development, and leach salts from the root zone. In a large-scale field study conducted at Camarillo, CA in 2009, we compared strawberry establishment using standard overhead sprinkler irrigation to either reduced sprinkler irrigation or drip-only irrigation with two different placements of four drip lines. Water use, electrical conductivity of soil in planting holes at 5 cm depth (EC), disease incidence, and strawberry performance were measured during the 8-week plant establishment period. Water use was reduced 34% in drip-only treatments and 20% in the reduced sprinkler irrigation treatment compared to standard sprinkler irrigation. Soil pore EC was generally greater in drip only treatments than in sprinkler irrigation treatments, ranging from 3.4 to 7.9 dS/m. In drip-only plots, placement of four drip lines on the bed surface and in planting rows reduced EC of soil 10-40%. Strawberry mortality was 70% greater in plots where drip tape was buried 5-10 cm deep compared to standard sprinkler, but was less than 2% in all treatments, a level acceptable for commercial production. Incidence of leaf spot and leaf blotch on strawberry leaves was 75% less in drip and reduced sprinkler treatments compared to standard sprinkler. Strawberry plants were also 13-18% smaller under standard irrigation compared to other treatments, but more uniform in size. Dry biomass of new leaves was similar among treatments, but new root biomass in reduced sprinkler and surface drip treatment was 26% and 51% greater, respectively, than with either standard sprinkler or buried drip irrigation. In drip-only systems, less root biomass was observed in central rows where soil EC was greater. Early fruit production was similar among treatments. These results suggest that reduced irrigation and precise water placement are adequate for strawberry establishment, provide substantial savings of water, and minimize runoff, a major benefit to the environment.

Specified Source(s) of Funding: UCCE

### **(216) Scheduling Irrigations on Drip-irrigated Vegetable Crops using Climate-based Coefficients and Canopy Measurements**

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As in all regions of the country, the southwest U.S. has experienced a resurgence of home gardens to provide fresh vegetables for the domestic table and for sale at increasing numbers of local farmers markets. Concurrently, the increasing demand for water in this arid region by rapidly rising populations and urban develop-

ment has forced many municipalities to either impose restrictions on outdoor water use or to provide incentives, including block-rate pricing structures, to encourage water conservation. If limited, or expensive domestic water is used to irrigate vegetable gardens, water conserving techniques such as drip irrigation and efficient irrigation scheduling must be implemented to minimize water-use while sustaining optimum yields and/or economic returns. This study was initiated to evaluate the yield/water relationships of drip irrigated chile pepper (*Capsicum annuum*), sweet corn (*Zea mays*), and tomato (*Lycopersicon esculentum*) in an effort to formulate climate-based scheduling coefficients for developing efficient irrigation management strategies for these vegetable crops when grown in small plots in northwestern New Mexico. Three to four drip irrigation treatments per year, ranging from 0.50 to 1.05 of Penman-Monteith standardized reference evapotranspiration (ET<sub>rs</sub>) were imposed on each crop in alternating block or randomized block experiments from 2004 through 2009. Irrigation treatment factors (TF) were held constant while canopy area varied in the equation used to derive volumetric, per plant, treatment levels:  $I = (ET_{rs} - EP) \times TF \times CA \times 0.623$ ; where; I = irrigation treatment (gals/plant), ET<sub>rs</sub> = reference ET in inches, EP = effective precipitation (60% of events > 0.2 inch) in inches, TF = treatment factor (ranged from 0.50 to 1.05 of ET<sub>rs</sub>), CA = canopy area (sq ft), and 0.623 = constant to convert inches/sq ft to gallons. Results varied slightly between years but overall, the optimum crop coefficients (K<sub>c</sub>) suggested for scheduling drip irrigations on chile pepper, sweet corn, and tomato were 0.80, 0.85, and 0.70, respectively when used in a simplified equation:  $IR = (ET_{rs} - EP) \times K_c \times D^2 \times 0.49$ ; where; IR = irrigation required (gals/plant), ET<sub>rs</sub> = Penman-Monteith standardized reference ET for tall crops in inches, EP = effective precipitation in inches, K<sub>c</sub> = crop coefficient, D = diameter of plant in feet, and 0.49 = constant to convert plant diameter to canopy area and inches per sq ft to gallons.

Specified Source(s) of Funding: Grant

### **(217) Irrigation Timing and Emitter Selection Affects Irrigation Efficiency and Plant Growth**

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Container nursery production requires large inputs of water and nutrients but often irrigation inputs exceed plant demand and lack application precision. As a result of excess irrigation, excessive leaching of nutrients, such as nitrogen and phosphorus from container growing systems, occurs. During a 3 year test, plant response and irrigation efficiency with micro-spray stakes combined with time of day of cyclic irrigation for production of container grown trees were evaluated. Irrigation efficiency was improved by 35% if applications were made in mid day or late afternoon with micro-spray stakes. Container leachate volume was greater with early morning and evening irrigation than mid day or afternoon irrigation. Nitrate-N and ortho-phosphate effluent was 67 and 64% less, respectively, in container leachate from mid day and late afternoon irrigation compared to early morning irrigation. Micro spray-stake design affected irrigation

efficiency. Double sided stakes or rings had less overspray in #15 nursery containers than traditional fan style stakes. Height growth of *Acer rubrum* 'Sun Valley' maples was similar when trees were irrigated in early morning, in late afternoon or a combination of both. Trunk diameter growth was 10% larger with plants irrigated in mid day or late afternoon compared to plants that received only early morning irrigation.

### (218) Nutrient Uptake Potential for Three U.S. Native Grasses and Tall Fescue

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There is interest in using native grasses for the mitigation of runoff in vegetated buffers and grassed waterways. However, little research has been conducted into the nutrient uptake potential of these grasses, particularly considering that runoff from some crop production operations may have high concentrations of N or P. A greenhouse experiment was conducted in Riverside, CA to determine the N and P uptake potential of three U.S. native grasses: *Leymus triticoides*, *Melica imperfecta*, *Vulpia microstachys*, and the non-native tall fescue, *Lolium arundinaceum*. Grasses were seeded into a soilless medium in 15-cm-diameter pots to a rate of 1000 plants/m<sup>2</sup>. Nitrogen was applied with irrigation water at either 0, 33, 67, or 100 mg N L<sup>-1</sup>, for a rates of 0–1380 kg·ha<sup>-1</sup> per 12-week experimental period. Water and P application rates were kept constant across treatments, with 26 L of water applied per 12 weeks and a P concentration of 22 mg·L<sup>-1</sup>. Shoot and root material was collected, dried, and analyzed for N and P concentration. Statistical differences ( $P < 0.05$ ) were found among grass species for water uptake, N uptake, P uptake, and apparent nitrogen recovery, suggesting some species may be more effective in removing water, N, and P from runoff. Least square mean water uptake ranged from 6.2 to 7.6 cm/week across species. Least square mean N uptake ranged from 35 to 60 kg·ha<sup>-1</sup> per week across species, with *Lolium arundinaceum* having the highest N uptake, and *Vulpia microstachys* numerically the least. Least square mean P uptake ranged from 5.5 to 11.2 kg·ha<sup>-1</sup>·week<sup>-1</sup> across species, with *L. arundinaceum* having the highest uptake. In general across species, as N application rate increased, N uptake also increased, though neither *V. microstachys* nor *M. imperfecta*

showed any difference in N uptake between the 33 and 100 mg N L<sup>-1</sup> treatments, suggesting that these two grasses had reached their N uptake potential in this range of applied N concentrations, for the conditions of this experiment. For all species, as N application rate increased, apparent nitrogen recovery decreased, suggesting that these grasses will exhibit a decreased efficiency in scavenging N when N concentrations in applied runoff are higher. These observations suggest that nutrient uptake potential is limited for these grasses, and that flow paths through grassed buffers or waterways may need to be longer when nutrient concentrations in runoff are high to achieve effective mitigation of nutrients in runoff water.

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### Topics of Concern in Human Issues and International Horticulture

#### (198) Mission of PROCINORTE's Tropical and Subtropical Fruit Task Force

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Canada, Mexico and United States are countries that share many interests in agricultural affairs. The three countries have been commercial partners for many years, and most recently they have been working under the North American Free Trade Agreement (NAFTA) umbrella. The three countries are natural commercial partners sharing several common problems in agriculture. Some of these problems are related to food safety and quality, control of pests and diseases, and other issues concerning food exports and imports. One very important mechanism to facilitate the institutional and technical integration of Canada, United States and Mexico is PROCINORTE under the umbrella of the Inter American Institute for Cooperation on Agriculture (IICA), Northern Regional Center. PROCINORTE is a cooperative Program in Research and Technology for the Northern Region, with an Umbrella Task Force that determines common research priorities. Within PROCINORTE, several initiatives or task forces have been formed. The Tropical and Subtropical Fruits

Task Force was established in 2002. The main goal of this task force is to improve production, consumption and trade of tropical and subtropical fruits in the entire PROCINORTE region. Specific objectives are to: 1) encourage the communications and collaboration among scientists working in quality, safety, and production of tropical and subtropical fruits; and 2) identification of common problems and opportunities associated with tropical fruit production and quality and work jointly in research projects to solve these. A summary of activities carried out by the Tropical and Subtropical Fruits Task Force is presented here.

### **(199) Horticulture CRSP Immediate Impact Projects Quickly Address Needs in Developing Countries**

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The Horticulture Collaborative Research Support Program (Hort CRSP), funded by USAID, awarded nearly \$2 million in early 2010 to support 15 one-year projects to improve the production and marketing of horticultural crops and products in the developing world. The collaborative research effort will be responsible for developing and leading a broad range of activities that demonstrate how horticulture can help reduce hunger and malnutrition and raise the incomes of the rural poor. Ten U.S. universities are collaborating with international organizations, agencies and institutions to conduct projects across 16 developing countries in Latin America, south and southeast Asia, and sub-Saharan Africa, from Costa Rica to Zambia. These Immediate Impact Projects (IIP's) address a wide range of issues, opportunities, and horticultural crops. Foci of the various projects include sustainable production, postharvest handling, enabling policy environment, food safety, germplasm improvement, nutritional value, and marketing. All projects emphasize information accessibility, technological innovation and gender equity. Activities of these Immediate Impact Projects include research, training, curriculum development, and outreach to developing country horticultural industries. While research, training and capacity building activities may focus mostly on the biological aspects of horticulture, the effectiveness of the projects will be measured by the adoption of practices developed and by impacts (i.e. economic, social and health) on the rural poor. The Horticul-

ture CRSP website, [www.hortcrsp.ucdavis.edu](http://www.hortcrsp.ucdavis.edu), will be used to demonstrate interactive information regarding these projects. This poster will briefly describe and illustrate the 15 Immediate Impact Projects, their target countries, collaborators, activities, expected results and impacts, and current status.

Specified Source(s) of Funding: Horticulture CRSP at Univ of California

### **(200) Competitive Index of the Chilean Shelled Walnut Exports**

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In recent years, global consumption of nuts has increased considerably indicating a world growth in demand. In this context, it is necessary to evaluate the competitiveness of exporting countries, like Chile in this export business of nut fruits. This work analyzes current market size and potential of the Chilean shelled walnut exports in addition to determine the quantitatively competitiveness of this market. The analysis was conducted for the period between 2002 and 2008, using indicators of competitiveness: relative trade balance, exchangeability, degree of export and import feasibility and indicator of specialization indexes. To determine the opportunities to develop profitable business, two models were developed: One that would assess the competitiveness of the main exporters through what has been called "matrix insertion into the international market". The second one deals with a "matrix of international demand" It was subsequently compiled a ranking to establish which exporting countries are more competitive in the business. The analysis showed that Chile proved to be highly competitive in shelled walnuts business of exports and these competitive capabilities showed to be superior to main competitors, U.S.A. and China. First place in competitiveness showed to be the Republic of Moldavia; the second place, it is sheared by Mexico and Chile. Nevertheless, both Mexico and Moldavia, according to the "Entry to the Market Index", are decreasing their market participation compared to Chile that presents the optimum and even increasing exports participation. There are still unexplored markets, which are potential buyers of Chilean shelled walnuts: the main China, the United States and Ukraine, which despite being the leading exporters, are also major consumers of walnuts. Moreover, there is a offseason advantage for Chilean supply.

Specified Source(s) of Funding: CEPOC, Univ of Chile.

### (201) Landscape Planning and Design at Buddhamonthon Park, Narathiwat, Thailand

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Buddhamonthon Park, Narathiwat is located at the south of Thailand. This park has a total area of about 142 rais. This study focuses on landscape planning serving for users by providing proper activities and design of Dhamma Park which provide Buddhism knowledge. The research method started from data accumulation by using interviewing technique, field survey, and literature review. The result of this planning and design was divided into 7 major areas; historical Buddha plant garden, auspicious plant garden, Buddha's Trail garden, meditation ground, peat swam garden, herb and native plant collection garden, and activities center.

Specified Source(s) of Funding: Faculty of Agricultural Technology

### (202) Using the RE-AIM Framework for Process Evaluation of Research and Extension Projects

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The RE-AIM framework is an evaluation framework designed to improve the ability to generalize evidence-based intervention research into practice. The five RE-AIM elements are Reach, Effectiveness, Adoption, Implementation, and Maintenance. Reach is the absolute number, proportion, and representativeness of individuals who are willing to participate in a program ([www.re-aim.org](http://www.re-aim.org)). Effectiveness or Efficacy is the impact the intervention had, positive or negative, on the specified outcomes. Adoption is the agents' and settings' decision to deliver a program. Implementation is how closely the delivery staff follows the program protocol. Maintenance refers to how and if the program continues beyond initiation as well as how individuals continue to meet program behavioral goals. Project PLANTS (Promoting Lifelong Activity and Nutrition Through Schools) is an overweight and obesity prevention program targeting children through after-school garden clubs. This presentation will explain how Project PLANTS is utilizing RE-AIM to evaluate the translatability and public health impact of the intervention.

### (203) Determination of Pollen Source and Environmental Conditions Related to Pollinosis

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Pollinosis, a pollen-induced allergy, is one of the most common climate-sensitive diseases. It usually happens during the period of April and May in Changchun, Jilin, China. To better understand the allergen of pollinosis, five slides mounted with a liquid of 1:1:1 (v/v/v) ethanol, glycerin, and water were placed on the top of 8 randomly selected buildings in Changchun Normal Univ for pollen collection every other day. The environmental data including air temperature and humidity were recorded to correlate with the medical records of pollinosis. The experiment started on 5 April and ended 25 May 2007. The result showed that the most frequent pollen sources are from *Ulmus*, *Populus*, *Salix*, *Juglans*, *Artemisia*, *Ambrosia*, and *Rosa*. High air temperature and low humidity increased the spreading of the pollen in the air, thus led to more pollinosis, whereas low air temperature and high humidity had less frequency. Further research on the response of pollinosis patients to each of the above identified pollen is under way.

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Springs F & G

## Weed Control & Pest Management

### (219) Preemergence Weed Control in Container-Grown Herbaceous Perennials

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During the 2009 season, two preemergence herbicides were applied to 12 container-grown herbaceous perennials and evaluated for weed control, phytotoxicity, and effect on plant growth. The herbicides and rates were: BAS 659H G (dimethenamid-p + pendimethalin) 2.97, 5.94 and 11.88 kg ai/ha and Certainty (sulfosulfuron) 91.2, 182.6 and 365.3 mL product/ha. Herbicides were applied to *Clematis integrifolia*; *Anemone* × 'Little Princess'; *Armeria maritima compacta* 'Rubrifolia'; *Asclepias tuberosa*; *Astilbe* sp.; *Dendranthema* × *morifolium*; *Gaura lindheimeri*; *Lamium maculatum* 'Orchid Frost'; *Liatris spicata* 'Kobold'; *Nepeta* × *faasseni* 'Walker's Low'; *Pennisetum setaceum* and *Lavandula angustifolia* 'Hidcote Blue'. Treatments were applied twice with 6 weeks between applications. The entire experiment was repeated twice with 2 weeks between the experiments. Plants were evaluated for phytotoxicity after 1, 2, and 4 weeks after applying herbicide treatments. In this study, BAS 659H G

(dimethenamid-p + pendimethalin) was safe to use on *Anemone*, *Clematis*, *Dendranthema* and *Nepeta* at all rates. However, BAS 659HG produced phytotoxic symptoms at all rates in *Asclepias*, *Astilbe*, *Lamium*, *Liatis*, and *Pennisetum*. It was safe at the 1× (label) rate but not at the 2× or 4× rates for *Gaura* and *Lavandula*. Certainty (sulfosulfuron) produced phytotoxic symptoms in *Armeria*, *Clematis*, *Lamium*, and *Lavandula* at all rates and would not be recommended for use with these plants. Effective weed control was provided BAS 659HG and sulfosulfuron with all but one treatment controlling more than 97% of the weeds.

Specified Source(s) of Funding: IR-4

### **(220) Detection and Management of *Phytophthora* and *Pythium* in Carrot, Tomato, Cucurbits, and Asparagus**

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To better understand and manage vegetable diseases caused by *Phytophthora* and *Pythium* spp., studies were conducted to: 1) develop a nested-PCR method to detect *Pythium* spp. responsible for carrot cavity spot, and qPCR method for *Phytophthora capsici* quantification from soil; 2) examine the relationship between cucumber fruit development and resistance to *P. capsici*; 3) screen pepper and tomato germplasm for resistance to *P. capsici*; 4) evaluate various fungicide chemistries for activity on *P. capsici*; 5) develop disease suppressive soil for managing carrot cavity spot; and 6) tested effects of cover crops on *P. capsici* population in cucumber and summer squash production. Methods and results are as follow. Resistant cucumber fruit [16 days post pollination (dpp)] did not prevent zoospore germination, but had fewer appressoria and more aberrant germ tubes of *P. capsici*. Pyrosequencing analysis of RNA from 0, 4, 8, 12, and 16 dpp fruit showed patterns of gene expression consistent with a profile of genes initially associated with cell division and rapid growth, followed by genes associated with defense. Germplasm screening showed pepper lines CM334, NY07-8007, NY07-8006, NY07-8006 were resistant to *P. capsici*. None of the commercial cultivars were resistant to isolate 12889. Tomato *Solanum habrochaites* accession LA407 was highly tolerant, and varieties Ha7998, Fla7600, Jolly Elf, and Talladega were moderately tolerant. When *Zucchini* 'Justice III' was grown in a *P. capsici*-infested field. Ridomil Gold MZ, Gavel, Kocide + Acrobat or Presidio or Revus or Ranman, all resulted in fewer dead or wilted plants than the untreated control. Cell packs were filled with *Pythium*

*ultimum*-infested media and drenched with fungicides prior to sowing carrot 'Napoli'. All chemicals except Ranman resulted in more emerged seedling compared to the untreated inoculated packs. Conventional, transitional, and organic farming systems were established. Soil samples from the plots were collected monthly, spiked with *P. ultimum*, and planted with cucumber seeds. The detrimental effects of *Pythium* spp. were reduced, but the beneficial effect of the elevated soil organic matter was fleeting. Both microbial activity and soil organic matter were positively correlated with disease suppression. In a commercial field infested with *P. capsici* oilseed radish (*Raphanus sativus*), oriental mustard (*Brassica juncea*), brown mustard (*B. juncea*), cereal rye (*Secale cereale*), and metam sodium affected soil microbial populations. However, the brassica cover crops did not impact disease incidence. Therefore, the cover crops can be used to improve crop rotation when *P. capsici* control is not the primary goal.

Specified Source(s) of Funding: USDA-SCRI

### **(221) Influence of Terbacil, Halosulfuron, Clomazone, and S-Metolachlor on Grafted Seedless Watermelon**

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Herbicide trials were conducted in 2009 to examine the effects of four herbicides on grafted watermelon. Field trials were located in Quincy, FL, Charleston, SC, and Kinston, NC. Watermelon plants utilized in the study include non-grafted Tri-X-313 watermelon and Tri-X-313 watermelon grafted onto gourd,

inter-specific hybrid squash, wild watermelon, and seedless watermelon ("self-grafted" to Tri-X-313) rootstocks. Two rates of terbacil (0.11 and 0.22 kg ai/ha), halosulfuron (0.35 and 0.53 kg ai/ha), clomazone (0.28 and 0.42 kg ai/ha), and S-metolachlor (1.07 and 1.42 kg ai/ha) were applied pre-transplant. Additional treatments included the same two rates of halosulfuron applied post-transplant and an untreated control. Phytotoxicity ratings were conducted at 19 days after transplanting and at one week following post-transplant halosulfuron application (27 days after transplanting). Yield was recorded at each of four harvests. Establishment of watermelons grafted to certain rootstocks was difficult at Quincy and Kinston. Due to low stand count, only data from Tri-X-313/gourd, Tri-X-313/inter-specific hybrid squash, and non-grafted Tri-X-313 was included from Quincy. Likewise, only data from Tri-X-313/gourd and non-grafted Tri-X-313 was included from Kinston. Each location was analyzed separately. At Quincy, all plant types (grafted and non-grafted) exhibited bleaching when clomazone was applied pre-transplant. Watermelons grafted onto gourd and inter-specific hybrid squash rootstocks appeared to be more tolerant of clomazone compared to non-grafted plants. All plant types also exhibited bleaching due to clomazone at Charleston. However, at Charleston, plants grafted onto gourd and inter-specific hybrid squash appeared to be less tolerant of clomazone compared to non-grafted plants. Considerable visible injury due to pre-transplant applications of S-metolachlor and halosulfuron was only observed at Kinston. No terbacil injury was reported at any location for any plant types. Pre-transplant applications of clomazone and S-metolachlor at Quincy resulted in significantly shorter vines compared to the untreated control for non-grafted plants and those grafted onto inter-specific hybrid squash. Injury was observed on all plant types at Quincy subjected to post-transplant applications of halosulfuron. Symptoms of injury included stem splitting, shorter vines, and an increase in the number of nodes at the distal end of the vines. At Charleston, post-transplant halosulfuron application did not cause such injury. At all locations, none of the herbicide treatments resulted in a significantly lower total marketable yield when comparing the same scion/rootstock combination from treated and untreated plots. At Quincy, only non-grafted plants had significantly lower early marketable yield following clomazone, S-metolachlor, and halosulfuron (high rate post-transplant) herbicide treatments.

Specified Source(s) of Funding: National Watermelon Association

## (222) Factors Important to the Decline in Biological Control of Spider Mites in Florida Strawberry Production

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Fresh market strawberries valued at \$313.6 million were produced on 8800 acres in Florida during the 2008–09 season. Main arthropod pests included the twospotted spider mite (*Tetranychus urticae*), cyclamen mite (*Phytonemus pallidus*), southern and fall armyworms (*Spodoptera eridania* and *S. frugiperda*), strawberry root and melon aphids (*Aphis forbesi* and *A. gossypii*), flower thrips (*Frankliniella bispinosa* and *F. occidentalis*), and sap beetles (various *Nitidulidae* spp.). Among those, the twospotted spider mite represents the greatest concern and is problematic in most fields and years. During the 2008–09 season, this pest was managed by the predatory mite, *Phytoseiulus persimilis*, on about 10% of the production area, down from about 50% 10 years ago. The technique involves scouting the crop until about 5% to 8% of the leaflets possess one or more spider mites then releasing predators once per season at about one per plant. Miticides were used to control spider mites on the remaining area. Season-long costs of the two methods were similar at about \$200 per acre. Farmers who once were committed to biological control methods and those never committed were asked why they were not presently using the method. The following main factors were revealed: (1) New, reliable miticides have been permitted thus reducing the need for an alternative method of control, (2) Financial investments for biological control must be made at one time, early in the season, before significant revenue has been generated from fruit sales, and (3) Difficulties in preserving a living control agent increased with the need for insecticides to control newly important western flower thrips (*F. occidentalis*), chilli thrips (*Scirtothrips dorsalis*), and spotted wing drosophila (*Drosophila suzukii*). In addition to factors offered by growers, there were others that likely contributed to the decline: (1) New miticides also have been available to the transplant producers resulting in cleaner shipments and reduced early to mid-season spider mite episodes, and (2) Strawberry growers, confident in the effectiveness of new miticides, have concluded that problems initiated even in the early season can be managed season-long with minimal miticide use and costs significantly under \$200 per acre. Decisions by growers to elect biological control are largely economic and without new market incentives, governmental regulations, etc. favoring the technique, its use will remain low provided sufficient effective miticides remain available.

Specified Source(s) of Funding: Univ of Florida

## (223) Antibiosis of the Aqueous Extract of Neem against Agave Weevil Adults

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The agave weevil, *Scyphophorus acupunctatus* Gyllenhal, is a destructive pest, it is a curculionid with a broad distribution in Mexico and causes significant economic losses in the agave plantation as well as to the tequila industry. Usually this insect pest is controlled with synthetic insecticides; however, the public ecological and environmental concerns demanded new alternatives to reduce the pest populations. The products obtained from the neem plant [*Azadirachta indica* A. Juss (Neem)] have been studied to control insect pests and diseases. The aqueous extracts of the neem seed contain several secondary metabolites such as terpenoids, phenols, and aminoacids. They show several host plant resistance mechanisms against insect pests. In this study we determined the antibiotic activity against agave weevil adults under laboratory conditions. We used five increasing concentrations: 0%, 5%, 10%, 15%, and 20% of a 99.6% concentrated aqueous extract. Adults of the agave weevil were placed individually in crystal flasks of 100 mL containing 2 × 2 cm<sup>2</sup> of papaya stalk, *Carica papaya* L., previously soaked in each concentration during 30 seconds, then a metal lid was placed on. The check and treated papaya portions were replaced each 2 days. Treatments were arranged in a bifactorial complete randomized design with 25 treatments (Factor A=concentrations; Factor B=exposure time) with 4 replications and 5 experimental units per replications were used. The evaluated variables were: body weight at 0, 2, 4, 6, and 8 days post-treatment, and percent mortality. Antibiotic effects were determined in the agave weevil adults, the concentrations of 15% and 20% caused cumulative

mortalities higher than 27%, and they caused body weight reductions due to a food dissuasive response.

*Specified Source(s) of Funding:* Universidad de Colima-Facultad de Ciencias Biológicas y Agropecuarias, Tecomán, Colima, México

## **(224) Optimizing Anaerobic Soil Disinfestation for Non-fumigated Strawberry Production in California**

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Soilborne disease management without use of chemical fumigants is a major challenge in California strawberry production. Anaerobic soil disinfestation (ASD) was developed in the Netherlands and Japan as an ecological alternative to methyl bromide fumigation. ASD involves incorporating an organic carbon source, irrigating to saturate the soil and then covering the soil with a plastic tarp to stimulate anaerobic decomposition of the organic carbon. The byproducts of anaerobic decomposition have proved toxic to many fungal pathogens and nematodes. The goal of this project is to optimize ASD for strawberry production in coastal California. We conducted a series of pot and then field experiments to test the efficacy of ASD across varying soil types, carbon sources, and seasons. Pot experiments showed that a) wheat bran, rice bran, mustard cake, grape pomace and ethanol all reduced *V. dahliae* propagules when used as a carbon source for ASD, and b) that cumulative reducing conditions of 50,000 CumEh mVhr (below 200 mV) are needed for effective reductions in *V. dahliae* propagules. Eh reduction near or exceeding 50,000 CumEh mVhr by ASD was observed in replicated field experiments in Ventura (2009) and Watsonville (2009–10). 88% and 54% reduction in native *V. dahliae* populations in soils was found in ASD plots in Salinas (2008–09) and Ventura (2009), respectively. Strawberry fruit yield in ASD plots in Moss Landing site with very low *V. dahliae* pressure was comparable with untreated check and surrounding methyl bromide treated field showing there is no carry over of toxicity of ASD to strawberry plants. Field experiments in Watsonville, Salinas, and Ventura are being repeated (with appropriate modifications) with the growers who are interested in ASD.

*Specified Source(s) of Funding:* USDA-Methyl Bromide Transition Program

### **(225) Evaluation of Chloropicrin Soil Fumigants for Management of Soilborne Pathogens in Chile (*Capsicum annuum* L.)**

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Soil fumigants, Pic-Clor 60 and Pic Plus (Hendrix & Dail, Greenville, NC), were evaluated in 2009 to determine effectiveness in managing soilborne pathogens in overhead, circular pivot-irrigated chile (*Capsicum annuum* L.). Pic-Clor 60 is a mixture of chloropicrin (60%) and Telone® (40%). Pic Plus contains chloropicrin (86%) and proprietary emulsifiers. Treatments included high (120 lb/acre) and low (60 lb/acre) rates of each fumigant and untreated control plots. Plots were arranged in a randomized complete-block design with six replications. Fumigants were tractor applied from pressurized containers on 21 February by shanking in the chemicals eight inches below the surface of the soil, followed immediately by a packing pass. Untreated plots were also physically shanked and packed, but no chemical was applied. Soil temperature at time of application was 60 °F. Plots were direct seeded with 'Villa 96' (3 lb/acre) on 20 Mar. and emergence occurred 11 Apr. Stand establishment (plants/plot) and vigor (plant heights) were measured every two weeks after emergence until thinning. On 1 July, soil cores for nematode counts were taken. A second nematode root galling evaluation was conducted after harvest and rated from 1 (no galls) to 6 (75% galled roots). One week before harvest, a visual wilt disease assessment was conducted. Marketable green chile fruit were harvested from each plot and fresh weight yields were determined. No differences were observed in stand establishment or plant vigor. No plant loss due to wilt diseases was observed in either the treated or control plots. Direct soil counts did not reveal root knot nematodes, however galling rates indicated higher root knot nematode populations in the untreated plots versus the treated plots, with the high rate Pic-Clor 60 and Pic Plus showing significantly less galling ( $P=0.05$ ) compared to the untreated control plots. Fresh weight yields appeared to correspond to the galling rates, with significantly higher yields ( $P=0.10$ ) in the high rate Pic-Clor 60 (21% higher yield) and the low rate Pic Plus (22% higher yield) plots compared to the untreated control plots.

Specified Source(s) of Funding: New Mexico Chile Association, New Mexico Chile Commission, and Hendrix and Dail

### **(226) Western Flower Thrips Feeding Damage on Susceptible and Resistant *Impatiens* Varieties**

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Western flower thrips [*Frankliniella occidentalis* (Pergande)] has become an increasingly significant pest problem in greenhouse ornamental production. Alternative strategies are needed to manage this pest because of limited number of available products and the ability of thrips to develop resistance. It is essential to evaluate thrips damage and to develop action thresholds for the implementation of either conventional or alternative management programs. This study was conducted to better understand the damages caused by thrips on thrips susceptible and resistant *impatiens* (*Impatiens wallerana*), 'Dazzler Violet' and 'Super Elfin Red', respectively. Plants at week 3, 6, or 9 in their production period were inoculated with 0, 25, 50, or 75 female adult thrips. Thrips were allowed to feed and develop on plants for a week and were removed by insecticide sprays. Plants were grown in the greenhouse for another 2 weeks and plant responses to thrips damages were evaluated by weekly observations. Visual damage ratings and number of leaves exhibiting damage symptoms increased when thrips inoculation density increase. 'Dazzler Violet' had more damaged leaves and fewer flowers than 'Super Elfin Red'. However, these cultivars had similar visual damage ratings for the same treatment combinations of plant age × thrips inoculation density. Plant age at the time of inoculation affected plant response to thrips damage, that younger plants exhibited more severe damage. These results suggest that plant age and thrips population levels on a plant are important factors to consider when developing action thresholds.

Specified Source(s) of Funding: NIFA Pest Management Alternatives Program

### **(227) Approaches in the Southern Region to Research and Extension for Sustainable Landscape Plant Production, Use, and Pest Management**

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One of the largest agricultural commodities in the U.S. is the Green Industry, consisting of various component industries linking landscape plant production and ultimate consumer use. Plant production alone involves thousands of species in containers, in-ground, under shade and in protected culture requiring myriad culture and management practices. Other aspects of the Green Industry include regulation, marketing, sales, design, installation, maintenance and allied industries. Green Industry use of sustainable practices is confounded by consumer purchasing patterns indicating low tolerances for imperfect plant products. Consequently, production and maintenance often involve high



use rates of water, fertilizer, and pesticides that are neither worker nor environmentally friendly. Attempts to develop sustainable production, maintenance and IPM strategies for the Green Industry have been challenged by the number of plant species, growing methods, climatic zones and site conditions across the U.S. Nevertheless, current emphases on sustainability necessitate innovation in developing integrated approaches to make landscape plant production and consumption more environmentally compatible. More than 45 stakeholders from eight states convened and developed a series of strategies for southeastern U.S. regional approaches to create sustainable landscape plant production, use and pest management. Stakeholders included scientists, producers, allied industry representatives and regulatory organization personnel. In facilitated sessions, the participants determined research, extension and regulatory priorities for the Green Industry. These ideas were discussed initially in terms of production/use, disease, arthropod and weed issues. Group participants found commonalities in strategies and tactics that delineate interactions between disciplines to facilitate integrated, transactional approaches to sustainable landscape plant production and use. Common themes and unifying concepts were explored in areas such as plant and pest phenology, water (quantity, quality, runoff, reuse and application methods), key pests, host plant resistance, plant-disease-pest ecological interactions and key production barriers. Participants then outlined a schedule of priority issues to address and thereby move the Green Industry toward more rapid change.

### **(228) Seasonal Chemical Variation in Lodgepole Pine Physiology: A Predictor of Mountain Pine Beetle Colonization Success?**

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Throughout western North America, mountain pine beetle (MPB) (*Dendroctonus ponderosae* Hopkins) outbreaks have caused extensive damage to lodgepole pine (*Pinus contorta* Dougl.) trees. Concern exists that MPB will spread to other hosts in the boreal forest of Canada. It has been previously thought that beetle colonization success is related to tree physiology, stand density, and drought. Host volatile organic compounds (terpenes) are utilized by insects to locate and recognize suitable host trees. From June through Sept. 2008 and again in 2009, un-attacked trees from four plots of decreasing density were studied within the Colorado State Forest Service State Forest,

Jackson County, CO. High beetle pressure was present during 2008 and 2009 seasons, and many studied trees were colonized and killed during the study. The research objective was to identify attributes of tree susceptibility, stressors, and resistance to beetle invasion by simultaneously quantifying water status (via water potentials,  $\Psi$ ), foliage volatiles (using headspace SPME-GC and GC-MS), and drought history ( $\delta C_{13}$  isotopes) over a density gradient in four plots. Preliminary results from season long water potentials and needle  $\delta C_{13}$  isotopes showed no severe water stress, yet SPME-GC analysis showed varying terpene profiles that varied with plot density. Tree needle profiles changed over the course of each summer and were markedly different in density extremes with some volatile compounds completely absent or present. The present findings indicate no severe water stress amid differing volatile emissions. Eighteen different compounds were identified in needle volatile emissions as separated by GC retention time. The trees were dynamic and changed according to their environment. Limonene, known for its toxicity to beetles, was seven times greater in the thinnest plot than the un-thinned control plot. Limonene decreased as density increased and with tree age. Limonene was also more prevalent in trees not successfully colonized. Volatiles fluctuated in their levels across the season within their own plots. This shows the dynamic fluctuation of tree physiology over the season.

### **(229) Bulb Mite Control in Easter Lilies**

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Bulb mites (*Rhizohlyphus robini* Claparede) have been an Easter lily (*Lilium longiflorum* Thunb.) pest since at least the 1890s. They appear to thrive in the southern Oregon/northern California coast's damp and warm weather pattern. Bulb mites feed on both bulb and root tissue, and while damage may occur in field grown plants, damage is more easily and commonly seen at the greenhouse forcing stage where the bulb mites tunnel into the bulb stem causing stunted plants, flower blasting, leaf deformation, or complete stem breakage. Bulb mites also feed on stem roots causing an overall weakness in plants. Kelthane WSP (active ingredient dicofol) has been the most effective treatment for bulb mites in Easter lilies over the last few decades; this product has the added benefit of having no known dermal sensitivity to handlers, making it safe to use. However, Kelthane WSP will soon no longer be available for ornamental use in the United States. The objective of this study was to determine the effectiveness of possible new pesticide options for controlling bud mites. Treatments included: 1) Kelthane WSP [dicofol]; 2) Cinnacure [cinnamaldehyde]; 3) Cinnacure + Safer Soap 1% [potassium salts of fatty acids]; 4) Sporan [rosemary oil]; 5) EF 500 [plant essential oils]; 6) Sanmite [pyridaben]; 7) Terraclor [PCNB]; 8) Promite [fenbutatin]; 9) Akari [fenpyroximate]; 10) Floramite [bifenazate]; 11) Kontos [spirotetramat]; 12) Safer

Soap 2%; 13) a wash in water followed by Safer Soap 2%; 14) a wash in water; and 15) an unwashed bulb control. Test bulbs were dip δ ped in the treatments for 30 minutes and then either sent for immediate mite extraction and counting or potted up and grown to full maturity following all routine commercial greenhouse protocols. Only Safer Soap at 2%, Terraclor, and Akari were as good or better at controlling bulb mites as the industry standard of dicofol. In the greenhouse setting, percent plant emergence was similar for all treatments, except for EF 500, which was slower than other treatments for emergence, and Akari and Kontos which showed better than average emergence. In the greenhouse, early growth had increased symptoms of plant chlorosis with Promite, Akari and Terraclor compared to other treatments. Sporan and the washed bulbs had the highest bud counts. While results are promising for some of these products, continued experiments are needed to extend labeling or pinpoint usage rate of these pesticides for greenhouse-grown Easter lily production.

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### (230) Current Situation of Spinach Downy Mildew in California

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Spinach downy mildew (*Peronospora farinosa* f. sp. *spinaciae*) is a devastating disease in many regions of the world. It was first reported in 1824 when Race 1 was discovered. Since then 10 more races have been reported and officially recognized. Currently there is one more tentative race, "Race N," which might be confirmed as Race 12. This tentative new race, thus far, has clearly been observed in two areas of the Salinas Valley (Soledad and King City) and was first identified in June 2009. From 1988 to 2008 Races 4 to 11 were reported. This disease is the most widespread and damaging spinach disease in California. The pathogen requires cool moist conditions to develop and infect plants. The high plant density in spinach which retains moisture, coupled with the fog and cool temperatures of the regions where spinach is grown, create ideal conditions for disease development. Spores are easily spread from plant to plant and from field to field by wind and splashing water. Under ideal conditions the pathogen spreads fast, and in addition to the damage caused by leaf spots, if not noticed in the field, could break down and rot when packed in bags and cartons. This pathogen is host-specific to spinach, but it is believed that some *Chenopodium* weed species might also be secondary hosts. The use of resistant cultivars is the most effective way to control downy mildew. For the past 50 years breeders have developed new resistant varieties as the new mildew races develop.

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Springs F & G

## Controlled Environments

### (123) Using Retractable Roof Greenhouses and Pot-in-pot System for the Development of a Double-crop Tree Liner Production

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In recent years, increased interest in retractable roof greenhouses (RRGs) and pot-in-pot (PIP) systems to accelerate tree liner/caliper production has occurred. PIP and RRGs as production systems to manipulate the growing environment have been shown to increase root mass and improve plant adaptation to stress versus conventional container or bare-root grown plants. Root dormancy as a physiological process to manipulate plant growth is unexplored in ornamentals. Media Geohumus amendments that increase plant water use efficiency during production and could potential carry through production to increase transplant survival in landscapes has not been explored. The objectives of this study are: evaluate root growth of landscape trees from cell (plugs) to 3-, 7-, or 15-gal black rounded pot when grown double cropped (6-month) vs. a 12-month-cycle in a RRG; 2) explore root dormancy and GEOHumus media amendments at up-shifting as means of manipulating plant growth. Three landscapes tree species, Red Maple (*Acer rubrum* 'October Glory®'), Avondale Redbud (*Cercis chinensis*) and Littleleaf Linden (*Tilia cordata* 'Greenspire®') were planted from tissue culture into 3-gal containers (black rounded pots) with a soilless mix. Planting occurred in Oct. 2008 with and out-planting to 7- and 15-gal PIP installations in June. Treatments consisted in Geohumus amendment in the media (1% by volume and no Geohumus), and Bottom heat mat treatments from December to March, at 42 °F (with and without bottom heat). All plants were irrigated using cyclic-micro-irrigation two times/day, applying 500 ml of water total. Plants were fertilized using a control release (CR) fertilizer (40g of Osmocote 19-5-8) applied at potting. A sample of plants was held in the 3 gallon pots in June to compare in September with the 7- and 15-gal PIP. Plants were harvested for growth measures in April, June and Sept. 2009. Measurements consisted of height, caliper (taken at 2.4 cm), leaf area, and shoot and root dry weights. The measures will be analyzed in ANOVA using PROC GLM at a least significant differences with  $\alpha = 0.05$  using SAS software (SAS Institute, Inc., Cary, NC). The bottom heat in treatment improve the growth of the plants during the various stages and was carried out after a year. Geohumus treatment was only significantly different in root dry weight on June harvest, and did not improve growth after a year.

## (124) Comparing Green Roof Growing Media and Plants in California

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Green roofing helps offset metropolitan regions' many negative environmental impacts. Vegetation, growing media, drainage and additional layers work in concert to reduce stormwater runoff, cool ambient air temperatures, sequester carbon, and a number of other environmental benefits. Several experiments across the U.S. have investigated which growing media and plant species perform best on green roofs, but little information exists about which growing media and plant species work best in California. The goals of this study were to compare 1) three growing media and 2) four plant groups under extensive green roof conditions (substrate depth <20 cm) on the central coast of California. Both studies evaluated performance of the treatments in terms of plant growth (percent cover). The growing media experiment investigated three media, placed on three 2.5 × 2.5 m platforms each divided into nine sections in a Latin Square statistical design (nine replications). 16 plugs, equally divided among four *Sedum* species, were placed in an equidistant 4 × 4 grid on the nine experimental units of each platform. Growth was measured weekly, using a 100-square evaluation frame placed above each section, and counting how many squares were filled with vegetation. Measurements continued for 6 months to determine which growing medium supported the fastest plant growth. Medium #3 (large particle size, 15% organic matter) had a significantly higher percent cover than medium #1 (lightweight foam) and #2 (small particle size, low organic matter) after 8 weeks. Medium #3 had 81% cover after 6 months, while medium #1 and #2 supported 61% and 72% cover, respectively. The plant species experiment used one growing medium to compare growth rates of four plant groups. Groups were sedum (*Sedum album*, *Sedum rupestre*, *Sedum rubrotinctum*, *Sedum spurium*), grasses (*Buchloe dactyloides*, *Bouteloua gracilis*, *Sporobolus airoides*, *Festuca glauca*), sedges (*Carex praepragilis*, *Carex divulsa*, *Carex glauca*, *Carex testaceae*), and taxa of interest (*Fragaria chiloensis*, *Delosperma cooperii*, *Dymondia margaretea*, *Achillea millefolium*). Plant groups were randomly placed on four platforms 2.5 × 2.5 m in a randomized complete block design (four replications). Growth was measured weekly, using a 100-square evaluation frame, for 6 months. After measurements were completed, the taxa of interest and the sedges had an average of 88% and 69% cover, respectively, while the sedum and grass groups had 59% and 61% cover, respectively.

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## (125) Light Emitting Diodes for Greenhouse Crops

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Light emitting diodes (LEDs) show promise to complement and replace current supplemental lighting equipment for greenhouse production. LEDs are characterized to use less electrical energy, offer opportunities to customize the spectral energy distribution, and have extended operational high output time frames with limited heat generation and release to the growing environment. Sizeable LED panel configurations are now available and suitable for crop production. Panels developed to support crop growth often provide light in the blue and red portions of the spectrum in support of photosynthesis. Most physiological processes in addition to photosynthesis are however, affected by the overall spectrum of the incoming light. Research is needed on proper LED wavelength compositions, configurations and photosynthetic photon flux (*PPF*) to most effectively support growth and proper crop development. Panels (300 W) with red LEDs (peak emission at 665 nm) supplemented with 10% blue LEDs (peak emission at 456 nm), tri-band LEDs with 40% red (660 nm), 40% orange-red (630 nm) and 20% blue (460 nm), and white LEDs, were tested in a controlled environment production area. Blackeyed Susan (*Rudbeckia hirta* 'Toto') was grown in 10-cm containers underneath the LED panels and as a comparison under high-pressure sodium-, metal halide- and 5T fluorescent lamps. The air temperature was maintained at constant  $20 \pm 2$  °C. *PPF* (400–700 nm) at plant height was about  $150 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  for all lamp types. An LI-6400 photosynthesis system (LI-COR, Lincoln, NE) with a clear top leaf chamber was used to measure net photosynthetic rate (*P<sub>n</sub>*) of plants developed to the stage immediately prior to open flower. Measurements were made on exposed single leaves at 400 ppm CO<sub>2</sub>. *P<sub>n</sub>* was in the range of 3.5 to 4.0  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  of CO<sub>2</sub> independent of lamp type, suggesting *PPF* to be more important for the rate of photosynthesis than the spectral energy distribution.

## (126) Effect of Hypobaria and Hypoxia on Photosynthesis, Dark-period Respiration and Growth of Lettuce Plants (*Lactuca sativa*) in NASA Advanced Life Support Systems (ALS)

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There are important engineering, safety, and materials handling advantages in growing plants under subambient conditions for extraterrestrial base and long-term spaceflight environments. We are studying the potential for producing plants under hypobaric (reduced atmospheric pressure) conditions, and manipulating hypoxic stress (low oxygen) to increase bioprotectant production in lettuce plants. Hypobaric conditions can lead to hypoxia, thus limiting plant photosynthesis and growth. Plants provide nutritional and functional (secondary metabolites – bioprotectants) needed to maintain good health—particularly important for astronauts exposed to ionizing cosmic radiation during long-term space exploration and habitation. A goal of this research was to enhance production of plant bioprotectants via hypobaria and hypoxia without reduction of plant biomass. This paper describes plant gas exchange and plant biomass production, while the companion paper elucidates the enhanced production of plant bioprotectants. Twenty-one day-old seedling lettuce plants (*Lactuca sativa* L. cv. Red Sails) were grown under variable total gas pressures [25 (hypoxia) and 101 kPa (ambient)] during 10-d studies with partial pressures of oxygen (pO<sub>2</sub>) at: 101/21 (ambient), 101/6 (hypoxia), 25/12, and 25/6 (hypoxia) pO<sub>2</sub>; two other treatments included exposing plants to 101/21 or 25/12 for 7-d, then to hypoxia (101/6 or 25/6) during the final 3-d of production. A 10-d exposure of ambient and hypobaric lettuce plants to hypoxia (6 pO<sub>2</sub>) reduced carbon dioxide (CO<sub>2</sub>) assimilation (CA), dark-period respiration (DPR), the ratio of CA/DPR (a measurement of photosynthetic efficiency), and subsequent biomass production. However, gas exchange and growth were comparable between non-hypoxic plants and plants exposed to hypoxia during the final 3-d of the production cycle. Hypobaria had no adverse effect on plant gas exchange or growth. The results also show that plants can be exposed to hypoxia during the end of the production cycle without adverse effects to gas exchange and growth.

Specified Source(s) of Funding: NASA

Wednesday, August 4, 2010

Springs F & G

## Fruit Crops 1

### (262) Commercial Potential of Rambutan Cultivars Grown at Two Locations in Puerto Rico

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Eight rambutan (*Nephelium lappaceum*) cultivars grown on an Oxisol and Ultisol were evaluated for 4 years under intensive management at Isabela and Corozal, Puerto Rico, respectively. There were significant differences in number and weight of fruits per hectare between locations and years. Significantly more fruits were produced at Corozal (390,004 fruits/ha) than at Isabela (153,095 fruits/ha). Fruit yield at Corozal and Isabela was 13,071 and 4,642 kg/ha, respectively. There were significant differences among varieties for number of fruit and yield per hectare at both locations. At Isabela, cultivar Gula Batu, R-162 and Binjai produced significantly more fruits and higher fruit weight than other cultivars averaging 199,495 fruits/ha and 5,919 kg/ha, respectively. At Corozal, significantly higher number of fruit and yield were obtained by cultivars Gula Batu and R-162 averaging 442,856 fruits/ha and 14,764 kg/ha, respectively. Cultivar R-156Y had the lowest yield at both locations. At both locations, significantly lower fruit soluble solids (Brix) values (19.8) were obtained from fruits of cultivars R-156Y and Gula Batu; there were no significant differences in Brix among the rest of the cultivars (21.2). Entomological studies demonstrated that rambutan is not a host to fruit flies *Anastrepha suspensa* and *A. obliqua*.

### (263) The Tropical Fruit Research Program of the USDA-ARS Tropical Agriculture Research Station

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Tropical and subtropical fruit crops are of major importance in commercial and subsistence agriculture. The globalization of the economy and the increased demand for healthy and more diverse food products have opened a large market for many of these fruit crops. Despite this fact, increased production of many tropical fruit crops is hindered by a lack of basic information on how physiological, entomological, horticultural, environmental, and pathological variables affect tropical fruit production systems and how these interact to influence yield and fruit quality. Promising germplasm of banana (*Musa acuminata*), mamey sapote (*Pouteria sapota*), papaya (*Carica papaya*), lychee (*Litchi chinensis*), longan (*Dimocarpus longan*), carambola (*Averrhoa carambola*), rambutan (*Nephelium lappaceum*), sapodilla (*Manilkara zapota*), atemoya (*Annona squamosa* × *A. cherimola*), and mangosteen (*Garcinia mangostana*) are being introduced by USDA-ARS, characterized, and evaluated at various ecological zones in Puerto Rico for tolerance to abiotic/biotic stresses, yield, nutrient use efficiency, and scion/rootstock compatibility. An understanding of the response of tropical/subtropical fruit crops to abiotic/biotic

stresses and agroenvironmental variables is critical to develop best management practices for the commercial production and marketing of non-traditional tropical/subtropical fruit crops. Results from recent research conducted by USDA-ARS in Puerto Rico with these crops are discussed herein.

### **(264) Effect of Gamma Irradiation as Quarantine Treatment on Quality Mexican Mango Fruits**

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Mexico is the main exporter of mango to USA, with 45 million boxes exported during the 2009 season. To prevent the spread of Mexican fruit flies (*Anastrepha ludens*), the fruit with maturity at  $\frac{1}{4}$  must be dipping in hot water (46.1 °C for 70-110 min depending on size fruit). This thermal stress modifies the ripening process and alters the sensory fruit quality and some varieties do not resist this treatment and they cannot be exported at that country. The USDA approved the application of gamma rays (0.15 kGy minimum and 1.0 kGy maximum) as alternative to hot water treatment; this procedure could be applied on mango fruit at  $\frac{3}{4}$  maturity and at room temperature which could improve the sensory fruit quality. But the postharvest behavior is unknown in different mango varieties submitted at these doses. The aim of this study was to evaluate the physicochemical and visual quality of six mango varieties ('Tommy Atkins', 'Haden', 'Kent', 'Keitt', 'Ataulfo' and 'Manila') harvested at  $\frac{1}{4}$  and  $\frac{3}{4}$  maturity stages,

submitted at 0, 0.15, 0.6 y 1.0 kGy and stored at 10 and 20°C during 19 days as well as in fruit transferred from 10 to 20°C for 6 days. At different periods the weight loss, firmness fruit, the skin and flesh color, titratable acidity, solids soluble content, ascorbic acid and visual quality were measured. As expected, the temperature affected significantly all response variables. All varieties in both maturity stages did not show external and internal damages when they were irradiated between 0.15 to 0.44 kGy but all varieties did present internal and external damages when they were irradiated between 0.92 to 1.52 kGy. The study suggested that the irradiation is not recommended in fruit of maturity  $\frac{1}{4}$  being better irradiate fruits of maturity  $\frac{3}{4}$ . The maximum dose tolerated depended on the variety; 'Kent' and 'Ataulfo' resisted to 0.86 kGy, while the varieties 'Tommy Atkins', 'Haden', 'Manila' and 'Keitt' showed visual damages at 0.6kGy. The physicochemical analysis data indicated that none of the variables can be an adequate indicator of the radiation effect because the responses depended on the variety, maturity stage and storage temperature.

*Specified Source(s) of Funding:* International Mango Board

### **(265) Abscisic Acid and Soybean Oil Effects on Early Season Peach and Grape Phenology**

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Freezes during or following cold deacclimation of deciduous tree fruits often limit yields. Our research has shown that soybean oil sprays before bud swell can delay peach bloom, reducing the potential of freeze damage. Research has shown that high levels of endogenous abscisic acid (ABA) are negatively associated with budbreak of several fruits. The objectives of this project were to determine if soybean oil and exogenous ABA sprays, separately or combined, delay grape bud and peach flower bud cold deacclimation and anthesis. 'Niagara' and 'Golden Muscat' grapes were sprayed with water (control), ABA 30025 (1000 mg/L), 3) ABA analog 30030 (50 mg/L), ABA 30025 (1000 mg/L) plus 2% TNsoy14 (96% soybean oil, a.i), or ABA 30030 (50 mg/L) plus 2% TNsoy14. Sprays of the ABA 30030 analog delayed 'Niagara' bud development and reduced shoot growth until onset of flowering. The 30030 analog was more biologically active than 30025. Both ABA formulations have potential to delay and/or reduce growth of grape vines. The 2% TNsoy14 treatment did not affect 'Niagara' bud phenology or shoot growth but the addition of 2% TNsoy14 ABA tended to further reduce 'Golden Muscat' shoot growth. 'Contender' and 'Nectar' peach trees were sprayed on 22 Feb. or 10 Mar. with water, 8% TNsoy14, ABA 30025 (1000 mg/L), or 8% TNsoy14 plus ABA 30025 (1000 mg/L). The two peach cultivars differed in

response to the treatments. The February sprays of 8% Tnsoy 14 delayed 'Nectar' flower bud development and anthesis (by 3 days) compared to control trees but soy oil sprays in March tended to advance bloom of both cultivars. 'Nectar' trees sprayed with TNsoy 14 tended to have slightly greater mortality of flower buds and less yields. However, soybean oil treated 'Contender' trees tended to have less bud mortality. The ABA treatments increased bud mortality on 'Nectar' trees ( $P=0.07$ ) compared to control trees but reduced it on 'Contender' trees ( $P=0.02$ ).

### (266) Effect of Several Management Practices on Olive Productivity in the Warm Climate of Mexico

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Olive world production is about 12 millions tons annually; however, 90% is for oil production and only 10% for table olive. The acreage in Mexico is 8051 ha and Sonora State is the main table olive production area with 2600 ha and production between 10,000 to 15,000 ton annually. The main variety used is 'Manzanillo'. The objective of this trial was to evaluate the Grower technology (GT) as control vs. INIFAP technology (IT) on table olive production. This experiment was carried out during 2007 at the Experimental Station (INIFAP). We established five commercial plots with growers (SPR Campo Aguilar, SPR Gilberto Mendez, Ejido Morelos, Experimental Station and Campo San Jose) using between 1.0 to 4.0 ha for each plot and olive trees of 6 to 16 years old and plant density between 100 to 200 trees/ha. The drip irrigation system was present only in three plots. The main components compared were artificial pollen applications using 'Sevillano', water management, adequate fertilization, and weed control. The harvest was carried out 15 July–25 Aug. 2007. Our results showed in the first year better yield of olive fruit using IT with means of yield of 6534 vs. 4556 kg·ha<sup>-1</sup> when we used GT. The increase yield in each plot varied from 24.8% to 91.2% and always using IT. The higher yield was observed on SPR Gilberto Mendez with 12,335 and 8,818 kg·ha<sup>-1</sup> using IT and GT, respectively. Fruit weight and flesh-to-pit ratio were nonsignificant in both technologies and among commercial plots. We did not record any important insect pests or diseases during this trial.

*Specified Source(s) of Funding:* INIFAP

### (267) Evaluation of Fig Cultivars for the Southeastern United States

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The common fig (*Ficus carica* L.) is widely planted in the southern United States, particularly in states along the gulf coast. Although commercial production is limited, homeowners enjoy fresh fruit during summer harvest from many popular cultivars. Several considerations need to be made when choosing a cultivar because of very humid conditions that occur during the harvest period. The cultivar must produce fruit with a closed or partially closed ostiole (eye) to reduce spoilage. Late summer defoliation, caused by several pathogens, limits fruit maturity in late season. Large fruit size (> 30 grams) influences yield and picking time. Mature tree size and architecture are also important considerations where space is limited. A comparison of 12 cultivars of common fig was made in Summer 2008. Fruit was evaluated for several characteristics based on marketing quality including color, soluble solids and fresh weight. Late summer defoliation caused by two pathogens was also evaluated. Cultivars that produce fruit with closed or partially closed ostioles (eye) have less fruit spoilage during wet weather. 'Hardy Chicago' and 'Celeste' yielded the most marketable fruit during periods of high rainfall. Several cultivars including 'LSU Purple', 'O'Rourke' and 'Champagne' have good resistance to late summer defoliation. Trees that had upright growth habit were 'Champagne', 'Celeste' and 'Hardy Chicago'. 'Tiger', 'Magnolia' and 'San Pietro' had a weeping or prostrate growth habit. The cultivars with largest fruit size were 'San Pietro', 'Magnolia', 'Tiger', and 'Kadota'.

### Wednesday, August 4, 2010 Springs F & G Genetics/Germplasm/Plant Breeding: Nursery Crops

#### (008) Cytogenetics of *Lantana camara* Cultivars Differing in Fertility

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*Lantana* L., a member of Verbenaceae, is a genus consisting of about 150 species. One of the species, *L. camara*, widely used in the landscape for its abundant flowering throughout summer and its drought tolerance, can invade natural areas and agricultural land through seed dispersal and outcross with the native Florida species, *Lantana depressa*. Development of cultivars that are either sterile or have reduced sterility would decrease invasive potential, and may also increase flowering and bloom period. Some cultivars of *L. camara*, such as 'Miss Huff', have been marketed as being sterile. The purpose of this study was to verify the mechanisms for male sterility of the triploid highly sterile cultivar 'Miss Huff' when compared to the tetraploid, fertile cultivar, 'Red Bandana'. Meiosis and pollen formation were evaluated. Inflorescences from each cultivar were collected in sizes ranging from 1 mm to 2 cm. These were fixed in a fresh, cold methanol: acetic acid solution (3:1, v/v) and stored for at least 24 hours. About 12-15 anthers were placed on each slide, stained with modified carbol fuchsin, and thoroughly macerated prior to evaluation under a microscope. Pollen in 'Miss Huff' was present as polyads and was variable in size, likely due to aberrant chromosome segregation at meiosis I. This finding indicates that the sterility of 'Miss Huff' is due to abnormal meiosis I as a result of either triploidy or aneuploidy.

### (009) Development and Across-species Transferability of Microsatellite Markers in *Lantana*

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*Lantana* L. is a genus of shrubby species common in the New World tropics and subtropics. Intra- and Inter-specific hybridization and polyploidization have made it difficult to differentiate varieties, subspecies, and natural versus naturalized populations. This study aimed to develop microsatellite markers to facilitate the analysis of genetic relatedness among cultivated *Lantana* varieties and species. SSR-enriched partial genomic library was constructed using genomic DNA of *L. camara* cultivar Lola. Out of the 384 genomic clones sequenced, 225 clones (58.6%) contained SSR sequences with five or more repeats. Three clones were found to be redundant and 30 clones had the SSR motifs close to the ends of sequencing reads, thus not providing enough sequences for primer designing. Nucleotide primers were designed for 109 unique SSR-containing sequences and 91 of these primer pairs amplified PCR products from 'Lola' genomic DNA, indicating a success rate of 83.5%. To assess the transferability of these SSR markers in *Lantana*, 49 pairs of primers were tested on one *L. canescens*, three *L. depressa*, two *L. involucrata*, and four *L. montevidensis* accessions. The transferability rate was the highest in *L. depressa* (59.2%), but it rapidly declined to 30.6% in *L. montevidensis*, 22.4% in *L. involucrata*, and 10.2% in *L. canescens*. The higher transfer-

ability of SSR markers to *L. depressa* indicates a lesser nucleotide divergence and a closer genetic relationship between *L. camara* and *L. depressa* than between *L. camara* and the other three species tested.

### (010) Development and Characterization of Microsatellite Markers for Population Genetic Analysis of *Coreopsis* Species

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Microsatellite markers have become a powerful tool for population genetic analyses. Few such markers have been reported for *Coreopsis*, a strictly New World genus with centers of diversity in Mexico, the Andes, and eastern North America. To develop microsatellite markers, genomic DNA of *Coreopsis leavenworthii* was sheared, and SSR-containing sequences were enriched using the "GA" SSR motif. Of the 384 clones sequenced, 16 sequences shared similarities with reported plant genes and nine sequences were similar to retrotransposable elements. One hundred and eighty one clones (47%) contained five or more simple sequence repeats. Among the SSR-containing clones, seven were redundant, and 20 did not have sufficient lengths of flanking sequences for primer designing. Based on the remaining SSR-containing sequences, 100 pairs of primers were designed. Sixty six pairs of primers were tested on *C. leavenworthii* genomic DNA and 61 (92.4%) pairs amplified PCR products. The availability of these SSR markers should facilitate DNA fingerprinting of *C. leavenworthii* and related species, understanding of their evolution, estimation of their genetic diversity, and in-depth analysis of their genetic relationship at the molecular level.

### (011) Development of Microsatellite Markers for *Caladium* Genetic Studies

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As DNA sequence-based molecular markers, microsatellite markers have become a very powerful tool for genetic studies. No such tool is available in *caladium*, an ornamental aroid commonly grown as pot or landscape plants. Previously, attempts were made to transfer microsatellite markers from taro to *caladium*, but few of taro microsatellite markers could amplify *caladium* genomic DNA. In this study, microsatellite markers were developed from 'Florida Sweetheart', a popular cultivar resulted from a cross between a lance- and a fancy-leaved cultivars. Sequencing 480 clones led to the identification of 370 clones (77.1%) containing five or more simple sequence repeats. Of 114 pairs of primers designed, 102 pairs amplified fragments of expected sizes and 61.4% of these markers were transferrable to other *Caladium* species. To demonstrate the usefulness of these

markers, we analyzed the relationships among 10 commercial caladium cultivars (*Caladium hortulanum*) and 38 species accessions, using 47 polymorphic markers. A dendrogram based on the binary matrix at 176 alleles grouped *C. humboldtii*, *C. picturatum*, *C. bicolor*, *C. schomburgkii* and 10 cultivars into one cluster. *C. bicolor* and *C. schomburgkii* accessions were most close to the commercial cultivars. Microsatellite data also supports the separation of *C. bicolor* var 'rubicundum' as a new species. These results indicate a wide range of possible utility for these markers in caladium genetic research.

### (012) Controlling Plant Architecture by Manipulation of Gibberellic Acid Signaling

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A common problem in the production of ornamental potted plants is their undesirably tall growth habit. Growth retardants that are most commonly used to control plant height include A-rest (ancymidol), B-nine (daminozide), Bonzi (paclobutrazol), Cycocel (chlormequat chloride), and Sumagic (uniconazole), all inhibitors of gibberellic acid (GA) biosynthesis. Given the high cost, potential environmental impact and possible phytotoxicity of these chemicals, we investigated interfering with GA signaling as an alternative approach. GA is thought to bind to a soluble GID1 receptor, which in turn binds to the DELLA repressor protein. The bound DELLA protein is then targeted for degradation by the proteasome, thus relieving DELLA-mediated repression of GA-dependent growth processes. To control plant height, we propose to interrupt GA signaling either by silencing receptor genes or by stabilizing the DELLA repressor. We have isolated three putative GID1 genes (PhGID1A, PhGID1B, and PhGID1C) from petunia. Virus-induced gene silencing (VIGS) of these genes results in stunted growth, dark-green leaves and late-flowering. We have also isolated the gai mutant gene (gai-1) from Arabidopsis. This mutant has a 17 amino acid deletion in the conserved DELLA domain of the GAI protein, which results in protein stabilization and extreme dwarfing in the mutant plants. We have generated transgenic petunia plants in which the gai mutant protein is over-expressed under the control of an alcohol-inducible promoter. This system permits induction of the dominant Arabidopsis gai mutant gene at a desired stage of plant development in petunia plants by simple application of alcohol. The mutant protein is expected to repress GA signaling and thus retard plant growth.

Specified Source(s) of Funding: USDA Floriculture Initiative

### (013) Assessing the Invasive Potential of *Lantana camara* Polyploids Based on Controlled Pollination

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Invasive plants have become a major concern because of their ability to spread, displace native plants, and alter ecosystems. In Florida the native species *Lantana depressa* has been threatened by *Lantana camara* that can pollinate the native and contaminate the native gene pool. Polyploids have been selected over the past decades in hope to reduce *L. camara*'s potential to cross-pollinate *L. depressa*. This study was conducted to assess the effectiveness of polyploidization on reducing such potential. Thirty-two *L. camara* polyploids, including 17 triploids, 10 tetraploids, two pentaploids, and three hexaploids, were used, and the control was three *L. camara* diploids. Controlled pollinations were performed in the greenhouse and seed set data were recorded. Results indicated that *L. camara* diploids were highly compatible with *L. depressa*. *L. camara* tetraploid, pentaploid, and hexaploids effected less seed set with the native than diploids, but most of the polyploids were still able to pollinate *L. depressa* and produce viable seeds. Although pollination of *L. depressa* with most of the triploids did not result in seed set, some triploids seemed able to produce viable pollen and cause seed set on *L. depressa*. Reciprocal crosses were also made to assess the potential of *L. camara* polyploids to produce seeds when pollinated by *L. depressa*. Overall, higher seed set percentages were observed when polyploids were the seed parents (*L. camara* x *L. depressa*) than when they were the pollen parents (*L. depressa* x *L. camara*). These results indicate a strong need to produce and test triploids for controlling *L. camara*'s invasive potential.

Specified Source(s) of Funding: USDA/TSTAR program, FNGLA Endowment

### (014) Vinca Cultivar Trials in Guam

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*Vinca (Catharanthus roseus (L.) G. Don)* is a frequently grown as a ground cover in Guam landscapes. Seeds of forty-nine vinca cultivars were germinated in flats under outdoor ambient conditions. Over half of the cultivars died before transplanting due to disease. Surviving cultivars were transplanted into five raised beds containing soil amended with compost. The soil surface was covered with plastic mulch which was subsequently covered with dry iron wood branchlets. Drip irrigation was installed under the plastic mulch. Flower diameter, petal length, petal width, leaf length, leaf width, plant height, and plant diameter were compared among the cultivars. Chlorophyll readings were also compared for leaves from the tops of plant and lower leaves. Vincas, in Guam, generally succumb to foliar diseases during months of heavy rainfall. Diseases commonly observed included



Phytophthora and Corynespora. A combination of less rainfall and the application of Banrot appear to have reduced the incidence of foliar disease during this trial. The Banrot treatment extended the survival of some of the cultivars through September, 2009. Cultivars began to flower 45 days after germination. The first cultivars to flower were: 'Pacifica Icy Pink', 'Heatwave Orchid', 'Heatwave White', and 'Santa Fe'. The last surviving cultivar was 'Heatwave Cherry'.

Specified Source(s) of Funding: USDA-NIFA, Hatch

### (015) A Preliminary Evaluation of Cold Hardiness in Six Asian Maple Taxa

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With the decreasing size of single family residential landscapes arises a need for small statured landscape trees. For northern U.S. landscapes, the demand is complicated by the need for cold hardiness. Plant suitable for use in USDA Plant Hardiness Zones 3 and 4 must be capable of withstanding minimum winter temperatures of -20 to -40 °F, depending on the location. From a size perspective, several Asian maples (Aceraceae) represent a potentially valuable source of germplasm for developing small, ornamental trees. However, relatively little is known about the cold tolerance characteristics of many of these species. As a first step towards identifying useful germplasm for our breeding program, we conducted laboratory freezing tests on seven maple taxa to assess their cold hardiness. In 2008, 4–6 year old containerized plants of *Acer barbinerve* Maxim., *Acer mandshuricum* Maxim., *Acer palmatum* Thunb. [cultivars Bloodgood, and Wolff (Emperor I)] *Acer pseudosieboldianum* (Pax.) Komar, and *Acer triflorum* Komar. (two genotypes) growing outdoors at the Horticultural Research Center in Excelsior, Minnesota were allowed to acclimate in the fall under ambient, outdoor conditions. In early November, the plants were moved into a minimally-heated overwintering structure to protect them from lethal cold temperatures. On five dates in 2008–2009, internodal stem sections of each taxon were collected, transferred to a programmable freezer, and sampled following exposure to a range of temperatures selected to bracket the killing point. Following treatment, the samples were incubated for 7 days at room temperature and then visually evaluated for injury with the aid of a dissecting microscope. Differences in maximum midwinter hardiness and timing of acclimation and deacclimation were observed among the species. *Acer pseudosieboldianum* and *A. triflorum* were the hardiest species overall and possessed maximum midwinter hardiness levels of -38 and -37 °C, respectively. The two *A. palmatum* cultivars, Bloodgood and Wolff, purported to be among the hardiest Japanese maple cultivars in cultivation, were less hardy than the other taxa tested on most sampling dates and would likely not survive in a typical Zone 4a winter. *Acer barbinerve* and *A. mandshuricum* were less hardy than either *Acer pseudosieboldianum* or *A. triflorum* but

exhibited sufficient hardiness to warrant evaluation of the range of cold tolerance extant in endemic populations.

### (016) Fruit Color in American Beautyberry Is Controlled by a Single Gene

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American beautyberry (*Callicarpa americana* L.) is a deciduous shrub native to the southeastern U.S. and is grown primarily for its metallic-purple fruit that develop in fall. There are also pink- and white-fruited forms but these traits are rare in nature and there is no information available regarding their inheritance. Also, there is confusion regarding self-compatibility and the presence of apomixis in *Callicarpa* L. Crosses were performed to investigate the genetics of fruit color, self-compatibility, and apomixis in American beautyberry. Testcrosses between *C. americana* (CA) and *C. americana* 'Lactea' (CAL) showed that white fruit is recessive to purple. White fruit appears to be controlled by a single recessive gene for which we propose the name white fruit and the gene symbol wf. While there were only a limited number of progeny grown, crosses between CA and 'Welch's Pink', a pink-fruited form, suggest that purple is dominant to pink. Test crosses between CAL and 'Welch's Pink' are needed to draw conclusions; however, we propose that purple, pink, and white fruit are controlled by an allelic series for which we suggest the gene symbols  $Wf > wf p > wf$ . Segregation ratios showed that all progeny in the study developed through sexual hybridization, indicating that apomixis is not present in these genotypes. All genotypes used in the current study were self-compatible.

### (017) Evaluating Fertility of Triploid Clones of *Hypericum androsaemum* L. for Use as Non-invasive Landscape Plants

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While *Hypericum androsaemum* L. is a valuable landscape plant, the species can be weedy and potentially invasive in certain locations. Infertile, non-invasive, cultivars of *H. androsaemum* with desirable ornamental features would be ecologically beneficial and valuable for the horticultural industry. The male and female fertility of 10 triploid *H. androsaemum*, developed with a combination of variegations and foliage colors, was investigated under greenhouse (controlled pollinations) and field conditions (natural pollination). Male fertility was evaluated based on pollen viability tests (pollen staining and pollen germination). Female fertility was based on fruit set, seed set, germinative capacity of seeds, and number of seedlings produced for each flower. Although values for different measures of fertility varied among triploid clones, pollen germination was significantly reduced for all triploids and nine of the 10 triploids produced no viable seed representing 100% failure of about 171,000 potential fertilization events (based on fertility levels of diploid controls). The remaining triploid clone produced 2 seedlings per flower (compared with 260 for the controls), but those seedlings died shortly after germination. This research documented that these triploid *H. androsaemum* are highly infertile with no measurable female fertility. These clones will provide ideal alternatives to fertile forms of *H. androsaemum* where naturalization is a concern. These methods also provide a rigorous protocol for evaluating fertility of other taxa that are selected or developed as non-invasive cultivars of potentially weedy species.

*Specified Source(s) of Funding:* USDA Floral and Nursery Crops Research Initiative

### (018) Insight Into the Genetic Cause of Sports or Reversions in Dwarf *Lagerstroemia*

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Miniature or dwarf crapemyrtles (*Lagerstroemia*) have been increasing in popularity since they were first introduced in the 1990s. However, some lineages have a tendency to send up “sports” or larger, faster-growing branches. These sports are characterized by more vigorous growth, earlier and more abundant flowers, and much greater seed set than the dwarf plant from which they came. Although the sport can be pruned off, if left alone it will eventually overgrow the miniature phenotype. Such a trait has obvious disadvantages for nursery and landscape settings. We studied the role of gibberellic acid (GA) as a possible cause of these anomalies. The effect of GA on plant growth (in vitro and whole plant) was determined, and molecular comparisons between sporting and non-sporting sectors were also made. Knowledge of what is causing this anomaly will be useful in selecting plants that do not have this trait. It could also be useful in gaining insight into genetic factors that control dwarfing in crapemyrtles.

Wednesday, August 4, 2010

Springs F & G

## Genetics/Germplasm/Plant Breeding: Vegetable Crops 2

### (044) US–1136, US–1137, and US–1138 Cowpea Germplasm Lines for Use as a Cover Crop

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The adoption of sustainable and organic cultural practices in recent years has resulted in an increased use of cover crops. Cowpea (*Vigna unguiculata* L.) is an excellent warm season cover crop due to its tolerance of heat and drought stress, ability to grow well in sandy, poor, acidic soils, high biomass production with high nitrogen content, and low fertilizer requirement. In 1997, field screening trials were initiated to identify cowpea populations suitable for use as a cover crop. The forty-seven populations in the initial studies included cultivars, germplasm accessions, and land races. Three populations were identified as having superior characteristics for use as a cover crop. All three were heterogeneous land races that were collected in South Carolina. A pure-line selection procedure was initiated to develop homogeneous lines. In 2006, the land race populations were grown in a field planting and three typical plants from each population were selected. In a 2007 field planting, the original three land race populations and the progenies of the three plants selected from each of the original populations were carefully evaluated for the following traits: rapid growth, good vigor, indeterminate growth habit, canopy height, and high seed quality. A single progeny population was selected from each of the original land race populations for release as a germplasm line. The three lines have relatively short photoperiods; flowering does not begin until day length is about 13 hours, and flowering and pod set continues in an indeterminate manner until plants senesce in late autumn or are killed by frost. The lines are homozygous for all important agronomic traits. They are resistant to the southern root knot nematode [*Meloidogyne incognita* (Chitwood) Kofoid and White] (many horticultural type cultivars are susceptible), and grow well without nitrogen fertilization. Iron Clay and other forage cowpea cultivars produce seeds with an impermeable seed coat. This trait enables viable seeds to overwinter in the soil, germinate the following spring, and become a weed in subsequent crops. The newly-released lines produce good quality seeds with high germination rates (>95%) and do not produce seeds with impermeable seed coats.

The adoption of these lines for use as a cover crop will eliminate the weed problem caused by dormant cowpea seeds. Samples of seeds of US-1136, US-1137, and US-1138 are available for distribution to all interested research personnel.

#### **(045) Determining Redundancy of Current and Collected 'Yellow Grano' Onion Accessions**

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The mission of the U.S. National Plant Germplasm System is to maintain a representative and genetically-diverse collection of germplasm while doing so in an efficient manner. Reducing genetically-duplicate accessions and adding new and different germplasm to the collection also maximizes genetic diversity. This was part of a study conducted to determine redundancies in the current 'Yellow Grano' onion (*Allium cepa* L.) germplasm in the U.S. collection. Some accessions appear to be duplicates as indicated by their similar cultivar names. An additional objective of this study was to evaluate recently-collected germplasm to determine if there are duplications among them, and between them and the current accessions in the collection. Eight 'Yellow Grano' accessions and collected cultivars were seeded in October of 2007 and in September of 2008. This group consisted of seven accessions that were already a part of the germplasm collection, and one newly-collected 'Yellow Grano' proposed to be added to the collection. As plants of each entry neared maturity, plants from each accession were measured for 18 different morphological characters. These characters included bolting percentage, sheath length and diameter, plant and leaf height, leaf width and thickness, and time when 20% of plants in the plot had reached tops down (20% tops down), 50% tops down, and 80% tops down. Bulbs were harvested at 80% tops down, and at that time, harvest date, pink root disease severity, and bulb number, height and diameter were measured. Two weeks after harvest, average bulb weight, bulb firmness, and the percentage of bulbs with a single growing point were measured. Three accessions in the current germplasm collection were determined to be duplicates of other accessions and may be removed from the collection. A newly-collected 'Yellow Grano' was not different from the 'Yellow Grano' entries already in the collection and would not add diversity to the collection. The most discriminating characters among this group were percent single centers, bulb diameter, shape index, and days to 20% tops down. The least discriminating characters were pink root incidence, sheath length and diameter, plant and leaf height, and leaf width and thickness.

*Specified Source(s) of Funding:* This research was funded through a germplasm evaluation grant from the National Plant Germplasm System.

#### **(046) Determining Redundancy within Six Groups of Current and Collected Short-day Onion Accessions**

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Efficiently maintaining a representative and genetically-diverse collection of germplasm is the mission of the U.S. National Plant Germplasm System. Reducing genetically-duplicate accessions and adding new and different germplasm to the collection maximizes its genetic diversity. This study was conducted to determine redundancies in the current short-day, onion (*Allium cepa* L.) germplasm collection in the U.S. Some accessions appear to be duplicates as indicated by their similar cultivar names. A second objective of this study was to evaluate recently-collected germplasm to determine if there were duplications among them, as well as, between them and the current accessions in the collection. Twenty different germplasm accessions and collected cultivars, assembled into six different similarity groups, were seeded in October of 2007 and in September of 2008. Plants from each accession were measured for 18 different morphological characters once the plants from each entry neared maturity. These characters measured were bolting percentage, sheath length and diameter, plant and leaf height, leaf width and thickness, and time when 20% of plants in the plot had reached tops down (20% tops down), 50% tops down, and 80% tops down. At the time of 80% tops down, bulbs were harvested and harvest date, pink root disease severity, and bulb number, height and diameter were recorded. Average bulb weight, bulb firmness, and the percentage of bulbs with a single growing point were measured two weeks after harvest. Some groups had a high degree of bolting and seven additional characters were measured from bolting plants of those entries. These characters were pink root disease severity, bulb height and diameter, shape index, scape length and diameter, and umbel diameter. No accessions should be removed from the collection, as none were identified as duplicates of one another. Ten newly-collected lines were deemed to be different from accessions already in the collection and may add some diversity to the short-day onion collection. Of the traits measured, bulb diameter and days to 20% tops down were the most discriminating among entries, while the least discriminating characters were sheath length and uniformity of maturity.

*Specified Source(s) of Funding:* This research was funded through a germplasm evaluation grant from the National Plant Germplasm System.

#### **(047) Mineral Concentration of Broccoli Heads in Relation to Year of Cultivar Release**

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It has been suggested that breeding for yield in agronomic and horticultural crops has resulted in decreases in mineral nutrient (e.g., calcium, magnesium) concentration of the harvested part of these crops. Broccoli has been cited as one horticultural crop that has exhibited such nutrient declines. Most of the claims regarding nutrient decline are based on historical data from United States and European nutrient databases that represent samples taken over many years assayed using variable methods and analytical equipment. Using historical data to evaluate possible changes over time has been criticized as a use of this data that was never intended. A better assessment of nutrient changes over time would be accomplished by conducting field tests of different cultivars released in different years but grown in the same environment(s). Thus, we undertook a study to evaluate mineral concentration of broccoli heads harvested from field-grown hybrids released over the last 30 years as well as from one older open-pollinated population. Broccoli heads from 14 cultivars were harvested from three replicated trials conducted in three fall environments in South Carolina. Concentrations of Ca, Cu, Fe, K, Mg, Mn, Mo, Na, P, S, and Zn were determined on a dry mass basis using ICP-OES. Observations indicate there were no consistent trends for all minerals as a function of year of cultivar release. In some years and with some minerals, older cultivars had the highest concentrations, while for other minerals the newer cultivars had the highest concentrations. Results do not appear to support a general concept of nutrient decline in broccoli associated with modern crop improvement.

*Specified Source(s) of Funding:* Federal

### **(048) Deployment of Nutrient-rich Nematode Resistant Carrots to Benefit Growers, Consumers, and the Environment**

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Carrots are an important source of nutrients for the U.S. diet and have \$550 million farm gate value to U.S. growers, but root-knot nematodes (*Meloidogyne* spp.) threaten about 3/4 of U.S. carrot crop. Nematode infection causes forking and galling disfigurement to carrot taproots resulting in 'cosmetic injury' and economic loss. New sources of genetic resistance to the two most important root-knot species affecting carrot production, *M. javanica* and *M. incognita*, have been identified in several unrelated germplasm sources from local carrot populations of diverse geographic origins including Brazil, Europe, Syria, China, and Australia. Inbred lines, single cross hybrids, and diverse populations from several sources of resistance have been developed and evaluated on a small scale in field test sites heavily infested with nematodes. These sources of nematode resistance vary widely in nutritional value attributable to both carotenoid and anthocyanin pigments, and also vary in flavor. This project

is moving nematode resistant carrots into mainstream production and also improving nutritional value of typical orange, nematode resistant carrots. The inheritance and genetic map location of resistance genes is being determined, and molecular markers are being developed to facilitate incorporation of resistance genes by indirect selection. Plants with superior levels of resistance have been selected and seed supplies of selected individual plants with elite high resistance were increased in collaboration with industry cooperators to provide adequate seed for larger scale testing in the upcoming year. Carrot types with unusual purple and yellow colored taproots that occur in resistant germplasm will also be available for large-scale and niche market growers. Seed companies and both large- and small-scale growers are involved in testing these improved carrot populations and hybrids. A web site is being developed to target large and small-scale carrot growers, and regular interactions with crop production and seed production industry personnel provide stakeholder input as a part of this project.

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Wednesday, August 4, 2010

Springs F & G

## **Landscape & Turf**

### **(326) Low Maintenance Options for Turf in the North Central U.S.**

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Low-maintenance turf is of interest due to low input requirements and positive ecological impact. Ten different mixtures: 1) Sunnyslawn (a mixture of perennial ryegrass, Kentucky bluegrass, fine fescue); 2) Wolfpack; 3) Bingo and 4) Grande II tall fescue; 5) Barcampsia *Deschampsia cespitosa*; 6) Barleria *Koeleria macrantha*; 7) Barkoel *Koeleria macrantha*; 8) *Poa compressa*; and 9) dryland ecology mix (perennial ryegrass, fine fescue, white clover, yarrow and other forbs); and 10) No Mow (mixture of fine fescue species); were planted at St. Paul and Rosemount, MN, in late summer 2004 and evaluated for 3 years for color and cover. Maintenance included 2-inch, 4-inch, and no mowing (twice annually); no irrigation after establishment; and an annual fall application of 0, 1, or 2 lb of actual nitrogen fertilizer. There were significant differences between the cover of the 10 mixtures. *Poa compressa* and Barcampsia almost always had significantly less cover than the ecology mixture, sunnyslawn and no mow. Grande II and Bingo usually provided significantly better cover than did Wolfpack tall fescue. Grande II and Bingo tall fescue along with ecology dryland mix and sunnyslawn were similar in cover and in this study, were acceptable low-maintenance turfgrasses in USDA Hardiness zone 4.

*Specified Source(s) of Funding:* Minnesota Extension Service

### (327) Native Grass Sod Suitability for Transportation and Competition with Resident Weeds

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Sod mixes for the California ecoregions of Pacific Forest, Sierran Forest, and Intermountain Sagebrush were grown at two different planting densities (500 and 1000 pure live seed per square foot) in 4 ft × 5 ft plots. High density sod, produced over eight months had significantly higher sod strength than the lower density sown sod. At harvest, both densities of sod were transported onto prepared soil beds with and without reinforcement mats. Known quantities of weed seeds were mixed in the top 2 centimeters of the soil beds. All sod rapidly established on the growing medium, regardless of density or reinforcement mat. Both the mat and high initial planting density sod suppressed weeds. The initial planting density and presence or absence of reinforcement materials affected the resulting species composition. All species transferred successfully, but *Bromus* and *Festuca* predominated with <5% comprising the remaining species in the mixes. The higher sowing densities proved more successful, suggesting that they are necessary for transport of native grass species mixes sod. Reinforcement mats aided in sod transport coherence and did not hinder establishment of the sod.

*Specified Source(s) of Funding:* California Department of Transportation

### (328) Effect of Repeated Short Interval Flooding Events on Growth of Five Native Shrub Taxa

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Plants in rain gardens must be able to tolerate repeated short intervals of flooding. Research was conducted to screen five native landscape shrub taxa for tolerance to repeated flooding events. On 13 Aug. 2009, thirty 3.8-L (1 gal) plants each of *Fothergilla xintermedia* L. 'Mount Airy' (dwarf witchhazel), *Ilex verticillata* L.A. Gray 'Winter Red' (winterberry), *Clethra alnifolia* L. 'Ruby Spice' (summersweet), *Callicarpa dichotoma* Lour. K. Koch 'Early Amethyst' (purple beautyberry), and *V. nudum* L. 'Bulk' (BRANDYWINE possumhaw) were removed from their containers and potted into 11.3-L (3 gal) containers in 5:3:1 pine bark:peat:perlite substrate and placed in a greenhouse in Auburn, Ala. Beginning on 28 Aug. 2009, plants were flooded to the substrate surface for 0 (non-flooded), 3, or 6 days (flood length). Following the flooding period, plants were allowed to drain for 6 days. During the draining period, no water was added to containers. The flood-drain process was repeated for 6 weeks. Non-flooded plants were hand watered as needed. The

experiment was terminated on 16 Oct. 2009. Flooding length had no effect on growth index (GI), root dry weight (RDW), or shoot dry weight (SDW) of *I. verticillata* and *V. nudum* 'Bulk'. Flooding length did not affect RDW and SDW for *C. alnifolia* 'Ruby Spice', however GI was similar and higher in plants flooded for 0 and 3 days than in plants flooded for 6 days. GI and RDW of *C. dichotoma* 'Early Amethyst' were not affected by flooding treatments, however SDW decreased with increasing flood length. GI of *F. xintermedia* 'Mount Airy' decreased with increasing flood length, and RDW and SDW were higher in plants flooded for 0 or 3 days than in plants flooded for 6 days. All taxa, with the exception of *F. xintermedia* 'Mount Airy', maintained good visual quality, had no reduction in root dry weight, and exhibited minimal effects of flooding on shoot growth. *F. xintermedia* 'Mount Airy' exhibited poor visual quality, and its growth was adversely affected by flooding, suggesting this taxon would not be a good choice for use in a rain garden. Conversely, all other taxa appeared tolerant of flooding and would be appropriate native shrub selections for rain gardens.

### (329) Examining the Effect of Established Conifer and Deciduous Trees on Soil pH

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The idea that leaf litter from coniferous trees reduces soil pH more than non-gymnosperm deciduous trees is frequently touted in popular horticulture literature as the reason plants are difficult to grow beneath conifers. Adding lime to elevate pH and growing acid tolerant plants are the commonly recommended solutions. We examined soil pH beneath 10 tree species (seven conifers: *Abies concolor*, *Larix decidua*, *Picea glauca*, *Pinus banksiana*, *P. ponderosa*, *P. strobus*, *P. sylvestris*; three non-gymnosperm deciduous trees: *Acer saccharum*, *Malus* sp., and *Quercus macrocarpa*) with two trees represented per species (20 trees total) at the Univ of Minnesota Landscape Arboretum, Chaska, MN. The trees were growing in their location for over 25 years and natural leaf litter was allowed to accumulate at their bases. Soil was sampled three directions out from each tree at 5-ft intervals (up to 20 ft). Soil samples at a depth of 0–3 inches and 3–6 inches were taken at each collection site. If leaf litter was lowering the pH during their tree's lifetime, we would expect to detect a pH gradient with

the lowest pH nearest the tree base. We found differences in soil pH across general locations at the arboretum (pH 5.9–7.6), but pH gradients by a specific tree or differences in average pH for the soil around coniferous and non-coniferous trees were not detected. Challenges to growing plants under conifers are likely due to factors other than soil pH.

### (330) Fertilization Rates Affect Color Intensity and Flower Earliness in Coleus in the Landscape

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Production practices can affect the landscape performance of ornamental plants. Nutrient management, especially nitrogen (N) and phosphorus (P) may affect leaf coloration and timing of flowering, two quality concerns in the container production of coleus [*Solenostemon scutellarioides* (L.) Codd]. In the first experiment, rooted cuttings of 'Mint Mocha', 'Indian Summer', 'Henna', 'Red Head', 'Trusty Rusty', and 'Red Ruffle' were grown in a greenhouse and fertilized with 0, 70, 140, 280, or 420 mg·L<sup>-1</sup> N or 0, 0, 6.2, 12.4, 24.8, and 49.6 mg·L<sup>-1</sup> P for 8 weeks. Plant growth was evaluated by plant size and biomass. Plant quality was evaluated by visual quality ratings and leaf color analyses. In the second experiment, 'Red Head' and 'Trusty Rusty' were grown under different N and P regimes that produce the most vivid color for 6 weeks and then planted in landscape beds to evaluate flower earliness in these plants. Results from the first experiment suggest that leaf color intensity decreased significantly when N rate increased to 280 mg·L<sup>-1</sup> though larger plants were obtained at this rate. Landscape evaluation indicated that earliness of flowering was not affected by different fertilization regimes within the range to produce quality coleus plants of the tested varieties.

### (331) Effect of Above- and Below-grade Planting on Four Landscape Trees in Southern California

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Four landscape trees (*Quercus agrifolia*, *Quercus virginiana*, *Schinus mole*, and *Cinnamomum camphora*) were planted in October 2008 at the following depths: 7.5 cm above grade; at grade; 15 cm below grade and 30 cm below grade. Trees were planted from nursery stock grown in 56 L containers. All trees

were irrigated three times per week by drip irrigation. Trees planted below grade were planted with 2 cm-diameter access tubes so that the buried root balls could be wetted directly without backfill/rootball interface issues. Basal stem caliper size ranked from least to most growth were: *Q. agrifolia*, *C. camphora*, *Q. virginiana*, and *S. Mole*. *C. camphora* had an inverse linear response to planting depth: trees that were planted deeper grew less. Planting at 30 cm below grade resulted in smaller caliper size compared to other planting depths for all species. Stem temperature for *S. mole* planted 30 cm below grade was higher than for other treatments, an indicator of stress for deeply-planted trees.

### (332) Effect of Deep Planting on Landscape Shrubs

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Six shrubs commonly planted in southern California landscapes, *Nandina domestica*, *Nandina domestica* 'variegata', *Ligustrum japonicum*, *Acacia redolens*, *Acacia redolens* 'Desert Carpet' and *Photinia farserii* were planted from 3.7 L containers at four depths: at grade and below grade at -2 cm, -4 cm and -9 cm. The experimental design was a randomized complete block with five replications. Shrubs were irrigated three times per week with drip emitters to simulate typical over-irrigation found in many landscapes. All shrubs were established in the first year before measuring growth in the second year. Six acacias, both *A. redolens* and 'Desert Carpet,' died in the second year: two were planted at grade and four were planted below grade. No other shrubs have died thus far in the third year after planting. Shrubs were pruned annually to maintain dimensions of 1 m<sup>3</sup> or 1 m<sup>2</sup> for acacia groundcovers. Shrub height and yield of clippings were species-dependent: nandina grew the least and acacia and photinia grew the most. Growth was not affected by planting depth, however, indicating shrub tolerance to deep planting. These results suggest wide latitude in planting depth for successful young shrubs, except for acacia, which may be more sensitive to below-grade planting.

### (333) SCRI-MINDS: Some Management and Communication Strategies for a National Coordinated Agricultural Project

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You receive the big grant, the accolades—and then reality hits. You have a big complex project with partners across the nation to get up and running—fast. Contracts need to be negotiated and signed, people hired and suddenly the Gantt chart at the back of the proposal seems so inadequate. Quarterlies are due, matching reports are required. What is one to do? Thankfully, your project has plan of governance and the institutional leads have thought through some of the key project management issues before submitting the grant, since now you really are now reliant on each other. If one cog isn't moving, this machine isn't going anywhere. This poster outlines the key components of our SCRI project management strategy and the tools we are using to ensure constant communication between our research, outreach and socio-economic teams, our advisory members and our grower partners. Most importantly, we outline how we are communicating our progress on a continuous basis to our industry and the public at large.

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**Wednesday, August 4, 2010  
Plant Nutrition 2**

**Springs F & G**

### **(176) Impact of Nitrogen Level and Form on Growth of Vetiver Grass**

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Vetiver grass (*Chrysopogon zizanioides* L. Roberty) is a warm season perennial grown for essential oil production, erosion control, and as a phytoremediation plant. It has also recently been proposed as a feedstock for biofuel production. Previous studies have focused on applications in treating various environmental problems; however, limited information exists on Vetiver fertility management practices in cropping systems. This study was undertaken to better understand the effects of

nitrogen (N)-level and N-form on Vetiver growth and development. Plant slips of *C. zizanioides* 'Sunshine' (Florida Vetiver Systems, Maitland, Fla.) with 2-3 tillers were greenhouse-grown in Normal, Ill. (lat. 40°30'N) using nutrient solution culture in a randomized complete block design with four replications. In the first experiment, N-level treatments were 26.3, 52.5, 105, 210 and 410 mg N/L with a ratio of 3:1 nitrate-N:ammonium-N. In a second experiment, the ratio of nitrate-N: ammonium-N was varied from 0:100, 25:75, 50:50, 75:25, and 100:0 while keeping a total N level of 210 mg/L. Weekly observations on plant height and tiller number were taken for both studies. After 12 weeks of solution culture, accumulated shoot, root and total fresh weights, total leaf number, and chlorophyll content were assessed. Plant height increased, then decreased quadratically ( $P=0.03$ ) in response to increasing N levels up to 10 weeks after transplanting (WAT) with maximum plant height at the 210 mg N/L treatment. However, at 12 WAT, there were no statistical differences among the N levels ( $P=0.67$ ). In the second experiment, the greatest plant height was observed at 50:50 nitrate-N:ammonium-N ( $P=0.01$ ) at 12 WAT. Vetiver accumulated the highest shoot fresh weight at 105 mg N/L and at 75:25 nitrate-N:ammonium-N. The greatest tiller number was observed at 26.3 mg N/L treatment ( $P=0.10$ ) and at 0:100 nitrate-N:ammonium-N ( $P=0.08$ ). Leaf number decreased linearly ( $P=0.10$ ) and chlorophyll content increased, then decreased quadratically ( $P=0.10$ ) as N level increased. Leaf number increased linearly ( $P=0.01$ ) as the ratio of nitrate-N:ammonium-N changed from 100:0 to 0:100. Results demonstrate Vetiver has a tolerance to ammonium-N and may successfully be cultured under lower N fertility in cropping systems.

### **(177) Calculating Average pH in Substrate Research: Should pH or [H+] Data Values Be Used?**

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Data on pH is often collected during research with container-growing substrates using the pour-through method or other extraction methods. A measure of acidity/basicity, pH is about equal to the negative of the base 10 logarithm of the molar hydrogen ion concentration ([H+]) of a solution. When analyzing pH data, a question that often arises among researchers is: Should the pH data values be converted to [H+] before calculating a mean value, then calculating the mean pH from the mean [H+]? However, a more general question may be preferable: What are appropriate measures of average acidity for substrate extract? When pH was measured from pour-through extract collected weekly over 12 weeks from 100 2.8-L containers of a compositionally uniform and accurately irrigated pine bark/peat moss/sand substrate, the distribution of the pH values was shown to be symmetrical (near-normal) from week to week, whereas the distribution the

[H<sup>+</sup>] values tended to be asymmetrical (skewed to the right). When a distribution is symmetrical, the (arithmetic) mean and the median are both acceptable measures of location, or average value. (With a perfectly symmetrical distribution, the mean and median coincide.) When a distribution is skewed, the median is typically a preferable measure of location since the median is less sensitive to extreme values than is the mean. Although the skewness of the [H<sup>+</sup>] values caused the distributions of the weekly data to show statistically significant deviations from a normal distribution, the deviations were not extreme. When values of mean pH calculated from pH values were compared with median pH calculated from pH values, mean pH calculated from mean [H<sup>+</sup>], and median pH calculated from mean [H<sup>+</sup>], all differences were within 0.02 pH units. Therefore, mean pH calculated directly from the pH data values is shown to be a valid summary measure of average acidity/basicity for container-substrate extract, with no data conversion from pH values to [H<sup>+</sup>] values being necessary. Median pH calculated directly from the pH data values was also a suitable summary measure of average extract acidity/basicity.

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### (178) Calcium Deficiency in Marigold

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Iron-manganese toxicity disorder in marigold has been related to high concentrations of Fe and Mn and low concentrations of Ca and Mg in the affected leaves. This disorder may occur because of high Fe and Mn availability in media and lack of Ca in many fertilizers used in greenhouse crop production. To investigate the effect of Ca nutrition on marigold (*Tagetes erecta* L. 'First Lady') growth, appearance, and nutrient (Mn, Fe, Ca, and Mg) accumulation in the plant tissue, a solution-culture study with various Ca concentrations (2.5 to 100 mg/L) was conducted. After 90 days of growth, concentrations of Ca up to 15 mg/L resulted in stunted plants with chlorotic and necrotic symptoms on the leaves. The concentration 20 mg Ca/L resulted in stunted plants free of symptoms. Concentrations above 20 mg/l resulted in healthy plants with no leaf symptoms or stunting. The concentration 20 mg/L Ca may thus be considered as the incipient deficiency concentration for marigold. At this solution concentration, the Ca in the plant shoots was 0.54% dry weight, which is a low concentration relative to well-nourished marigold. Relative to adequate Ca nutrition, a low supply of Ca had no effect on Fe concentration in the growing point (buds and newest leaves) but resulted in a high concentration of Fe

in the old leaves and old stems. Calcium deficiency did not affect the concentration of Mn in the old parts of the shoots but resulted in high concentrations of Mn in the growing points. Low Ca in the solution resulted in low Ca and high Mg in the shoots. This research suggests that inadequate Ca nutrition lead to increased Mn in marigold making it susceptible to Fe-Mn toxicity disorder.

*Specified Source(s) of Funding:* Risk Management Agency

### (179) Manganese Toxicity in Marigold as Affected by Calcium

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Iron-manganese disorder in marigold has been related to high concentrations of Mn and low concentrations of Ca in the affected leaves. Preplant addition of micronutrients in the media combined with constant feed program and low medium pH create favorable conditions for the development of Mn toxicity in greenhouse crops. Deficiency of Ca is due principally to low Ca in some fertilizers used in greenhouse production. To investigate the effects of Ca on Mn toxicity (growth, appearance, and nutrient concentrations) in marigold (*Tagetes erecta* L. 'First Lady'), a factorial, solution-culture study with various Ca (20 to 100 mg/L) and Mn (0.5 to 6.5 mg/L) concentrations was conducted. Treatments 20/6.5, 20/4.5, 20/2.5, and 100/6.5 mg/L Ca/Mn concentrations resulted in stunted plants with small brown spots, interveinal chlorotic patches and necrotic symptoms on the tips and margins of the leaves, and deformed leaves. Treatments 20/0.5, 100/2.5, and 100/4.5 resulted in stunted plants relatively free of symptoms. The treatment 100/0.5 resulted in fully grown and healthy looking plants. Concentrations of Ca at 20 mg/L (incipient deficiency concentration of Ca in marigold) reduced the critical toxicity concentration of Mn from 4.5 to 2.5 mg/L nutrient solution. The interaction between Ca and Mn in the solution had a highly significant effect on Fe and Mn in the plant tissue. Low Ca and high Mn in the medium resulted in increased concentration of Fe in the roots and Mn in the leaves and stems. At 20mg/L Ca in the nutrient solution and high Mn, the roots Fe was 1300 mg/kg dry weight (DW) whereas the Mn concentration in the roots, new leaves and old leaves were 500, 1300 and 1600 mg/Kg DW respectively. These results suggest that low Ca and high Mn nutrition lead to the Fe-Mn disorder in marigold.

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### **(180) Mycorrhizal Colonization Improves Nutrient Uptake Efficiency of *Nassella pulchra* in Nursery Conditions**

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The interest on mycorrhizal technology to create more sustainable horticultural practices is increasing. Mycorrhizal colonization improves plant nutrient uptake offering the possibility to maintain crop yields at reduced fertilizer levels. We investigated the effects of mycorrhizal colonization on the growth and nutrient uptake of *Nassella pulchra* (purple needlegrass), a California native plant widely propagated for ornamental landscapes and ecological restoration. Mycorrhizal and nonmycorrhizal plants of *N. pulchra* were grown in a soilless mix with 0, 28, 50, 75, and 100 ppm of nitrogen (N) and 10 ppm of phosphorus (P). Plant growth, mycorrhizal colonization, and the content of N and P in shoots was analyzed. Mycorrhizal colonization increased the growth of *N. pulchra* plants grown with 75 ppm of N but had no effect on the growth of plants grown with 0, 28, 50 and 100 ppm of N. There were no significant differences between the shoot height, shoot dry mass and total dry mass of mycorrhizal and non mycorrhizal plants of purple needlegrass grown in the latter N rates. Mycorrhizal colonization improved the nutrient uptake efficiency of *N. pulchra*. Mycorrhizal plants grown with 75 ppm of N reached the same growth than nonmycorrhizal plants grown with 100 ppm of N. In addition, mycorrhizal plants of *N. pulchra* had greater P contents than nonmycorrhizal plants at all N rates, independently of their growth responses to mycorrhizal colonization.

### **(181) Use of Mycorrhizal Colonization to Reduce Nitrogen and Phosphorus Leaching from Nursery Containers**

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The objective of our study was to investigate the effects of mycorrhizal colonization on N and P leaching from nursery containers. Mitigation of nitrogen (N) and phosphorus (P) leaching has become a major goal of the California nursery industry. Plant production in containers is a significant source of surface water and groundwater contamination. Commercial nurseries use large amounts of fertilizers and water that exceed the crops' nutrient requirements and the water holding capacity of the growing media. Arbuscular mycorrhizal (AM) fungi are a group of microorganisms specialized to colonize the roots of most plants. These fungi produce hyphae, which grow in and around the roots and develop an extraradical mycelium that enhances the plant ability to acquire mineral nutrients and water. We compared the growth response and the content of nitrate, ammonium and orthophosphate in leachates obtained from mycorrhizal and nonmycorrhizal plants of *Rhus integrifolia* and *Encelia californica* grown in a nursery mix with no fertilizer or with half or full rate of 18N-6P-12K Osmocote controlled release fertilizer. Mycorrhizal plants grown in half and full rate of Osmocote were taller and larger than nonmycorrhizal plants. Mycorrhizal colonization increased the nutrient use efficiency of *R. integrifolia*. Compared to the plants grown with half rate of Osmocote, full rate of Osmocote increased the growth of mycorrhizal plants but not of the nonmycorrhizal ones. Mycorrhizal colonization increased the content of N and P in *R. integrifolia* shoot tissue, and the P content of *Encelia californica*. The effects of mycorrhizal colonization on the content of N and P in leachates will be discussed.

### **(182) Effect of Nitrogen Availability on Mineral Nutrient Uptake and Plant Growth of Container-grown Hydrangeas**

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Rooted liners of *Hydrangea macrophylla* 'Red Star' were fertigated with one of three nitrogen (N) concentrations (0, 140, or 280 ppm) in a modified Hoagland's solution from June to November. Every 3 weeks starting in June, plants in each N treatment (0 N, 140 N, 280 N) were destructively harvested to determine plant growth and mineral nutrient uptake. The 0 N

plants did not accumulate any significant biomass during the experiment. Biomass accumulation pattern was similar between 140N and 280 N plants. Total plant dry weight of 140 N and 280 N plants increased slowly during the first 6 to 9 weeks after planting, increased rapidly between 9 and 21 weeks, and was relatively stable after 21 weeks. By the end of the experiment the 280 N plants accumulated 92% more biomass than 140 N plants. Plant nutrient (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, and B) accumulation followed the similar pattern as the total plant biomass accumulation for 140 N and 280 N plants. There was very limited uptake of all mineral nutrients during the first 6 to 9 weeks after planting. Uptake of all nutrients increased rapidly from 9 to 18 or 21 weeks, coinciding with the period of rapid plant growth. For plants that did not receive any N, there was no significant uptake of any mineral nutrients. Increasing N-availability increased the uptake of all nutrients. Results are discussed in terms of optimizing fertilizer use by modifying timing of fertilizer application during container production of *Hydrangea macrophylla*.

### (183) Is Potassium (K<sup>+</sup>) Key to Enhancing Plant Growth?

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More intensive farming practices to meet growing food demands are leaving much of the soils depleted of nutrients. Much is known about Nitrogen and Phosphorus status in soils and its effect on plants however information is lacking on Potassium's role in defending plants against abiotic stress. Potassium, an essential plant nutrient plays an important role in a number of physiological and biochemical processes that link to resistance to abiotic stresses. The focus of the study was to investigate the relationship between the supra and suboptimal potassium status of cucumber (*Cucumis sativus* L.) and its effect on the growth and development. Cucumber seedlings were treated with six different mM concentrations of potassium (1, 2, 4, 6, 8, and 12) for 70 days. The leaf chlorophyll content, number of fruits, fresh and dry weights increased with an increase in K supply from 1 to 6 mM and, highest was in treatment supplied with 6 mM potassium. Treatments above 6 mM responded negatively to increase in potassium supply. The substrate pH ranged from 6.05 to 6.12. The substrate pH increased linearly with an increase in K supplied from 0.8 to 3.4 dS.cm<sup>-1</sup> and it could be contributing factor for decline in growth at 8 and 12 mM potassium concentration.

Wednesday, August 4, 2010

Springs F & G

## Produce Quality/ Health Properties 2

### (151) Enzymatic Properties of Yeast Expressed Tomato Beta-galactosidase (TBG)1

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Fruit softening occurs by several mechanisms, including modification of cell wall structure by cell wall degrading related enzymes. The most important change in tomato fruit, cell wall composition is the loss of galactosyl residues throughout development and ripening. In order to understand the role of galactosyl turnover in cell wall components, we successfully produced recombinant tomato  $\beta$ -galactosidase (TBG) fusion proteins in yeast. Previously, we reported the properties and substrate specificity of TBG1, 4 and 5. Here we assessed enzymatic properties and substrate specificity of TBG1 in detail using several linked galactooligosaccharides. Optimum pH of partially purified TBG1 was 5, and optimum temperature was 40 °C. The  $K_m$  for TBG1 was 0.45 mM,  $V_{max}$  was 0.13  $\mu$ M/s, and the  $IC_{50}$  by galactose was 0.24 M, using *p*-nitrophenyl- $\beta$ -D-galactopyranoside as substrate. Using several galactooligosaccharides has  $\beta$ -(1 $\rightarrow$ 3),  $\beta$ -(1 $\rightarrow$ 4) and  $\beta$ -(1 $\rightarrow$ 6) linkages. TBG1 released galactosyl residues from wide range of several galactooligosaccharides. When using  $\beta$ -(1 $\rightarrow$ 6)-galactohexaose as a substrate, the hydrolyzed pattern of TBG1 shows exo- $\beta$ -(1 $\rightarrow$ 6)-galactosidase/ galactosyl transferase activities. Using tomato fruit cell wall materials, TBG1 released galactosyl residues from a variety of fruit stages and cell wall fractions. These results suggest that TBG1 which has strong  $\beta$ -(1 $\rightarrow$ 3)-galactosidase and exo- $\beta$ -(1 $\rightarrow$ 6)-galactosidase/ galactosyl transferase activities, may hydrolyze to targeted arabinogalactan II in structure of wall pectic polysaccharides.

### (152) Variability of Free Sugars, Organic Acids and Capsaicinoids in *Capsicum baccatum*

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Variability in the concentrations of free sugars, organic acids and capsaicinoids that contribute to fruit flavor in *Capsicum baccatum* is not well understood. We evaluated mature green fruit of >230 non-cultivated and cultivated accessions of *C. baccatum* var. *baccatum* and *C. baccatum* var. *pendulum* acquired from the USDA/ARS *Capsicum* genebank in Griffin, GA. Concentrations (mg/100 mL juice extract) of sucrose, glucose and fructose in fruit ranged from 0 (not detected) to 451, 177 to 3,012, and 38 to 1,241, respectively, with associated median values of 5, 1,154 and 541. Total sugar concentration ranged from 0.3 to 4.0% with a median value of 1.7%. Concentrations of organic acids ranged from 20 to 2,016, 0 to 86, and 0 to 457 mg/100 mL juice extract for citric, malic and isocitric acids, respectively, with associated median values of 477, 35, and 8 mg/100 mL extract. Citric acid was generally the predominant acid among accessions. Concentrations of capsaicinoids among accessions ranged from 0 to 8,961, 7,858, 680, 752, and 324 mg/g dry weight for capsaicin, dihydrocapsaicin, nordihydrocapsaicin, homocapsaicins and homodihydrocapsaicins, respectively, with associated median values of 2,063, 888, 180, 71, and 35 mg/g dry weight. Capsaicin was generally the most abundant capsaicinoid. Pungency among accessions ranged from 116 to 214,531 Scoville heat units/g dry weight with a median value of 55,300. Variability in the concentrations of free sugars, organic acids and capsaicinoids is sufficiently large that genetic manipulation may enable the development of improved *C. baccatum* cultivars with novel flavors and the introgressions of desirable flavor attributes into bell pepper (*C. annuum*) breeding lines.

### (153) Analysis of Rutin Content in Asparagus Cultivars for the Development of Value-added Products

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Rutin, a flavonoid commonly found in higher plants, has numerous health benefits including reduced risk of cancer, reduced incidence of coronary heart disease and increased life expectancy. Cultivar, climate and location can have significant effects on rutin concentration in asparagus; light intensity is especially important. Variation in rutin content over a six-week harvest season was examined by collecting spear samples of cultivars, 'Jersey Giant' and 'Guelph Millennium', at weekly intervals from two locations at the Simcoe Research Station. Samples were also collected from five commercial fields in unique geographical regions of Southwestern Ontario. 'Guelph Millennium' consistently had higher rutin content than 'Jersey Giant' at the Simcoe Research Station. Rutin concentrations were variable among commercial fields and no consistent cultivar

effect was observed. At the different locations sampled rutin concentration, increased, decreased, or remained stable as the season progressed. The function of rutin in the plant is to protect photosynthetic cells from UV-B radiation damage caused by sunlight. Therefore, fluctuations in rutin content during the season are highly dependent on weather conditions that affect light intensity and duration.

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### (154) Fruit Tissue Elements and Carotenoids in 'Micro-Tina' Tomato Respond to Foliar Chelated Titanium

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Titanium (Ti) is the ninth most abundant terrestrial element. Average Ti concentration in plants is 1 mg/kg dry weight; however, large variations in Ti concentrations exist among different food crops due to differing regional soil and climatic conditions. Titanium is non-toxic to humans and is often used in surgical and dental implants. Food is the principal source of Ti in human diets, with an average intake of 300 to 800  $\mu\text{g}$  Ti/day. Even though Ti is poorly absorbed by plants, high concentrations can occur in food crops in localized areas. Titanium exerts interesting influences on plant physiology. Some research demonstrates Ti can be beneficial to plant growth at low concentrations, while higher Ti concentrations are very phytotoxic. Recently, the beneficial effects of Ti have been described using the theory of "hormesis". Titanium uptake initiates defense responses in plants (increases in elemental uptake, production of secondary metabolites, and up-regulated antioxidant systems). These defense reactions increase the health status of the plant and counteract any negative effects associated with increased tissue Ti. Therefore, a study was undertaken to determine the impact of foliar applications of chelated Ti on quality factors in tomato fruits. 'Micro-Tina' tomatoes (*Lycopersicon esculentum* Mill.) were grown in nutrient solutions and sprayed with a commercial chelated Ti. 'Micro-Tina' is a red-fruited, dwarf tomato cultivar with a short, compact growth habit. A total of four foliar applications were made prior to flowering at 3 day intervals at concentrations of 0, 250, 500, and 1,000 mg Ti/L. Fruit was harvested, graded and evaluated for yield, mineral nutrients, and carotenoid pigments. Total fruit yield and weight of ripe fruits were not influenced by foliar Ti treatments. Total fruit BRIX decreased with increasing foliar Ti treatments. Foliar Ti did not

influence fruit beta-carotene, or lycopene concentrations. Fruit tissue lutein increased, then decreased in a quadratic response to increasing foliar Ti concentrations. Fruit tissue Ti was below detection limits. Calcium was the only element in the fruit to respond significantly to Ti treatments, increasing with Ti foliar concentrations. Foliar applications of Ti to 'Micro-Tina' tomato influenced fruit tissue Ca and lutein concentrations; however, impacts on other fruit quality factors were minor.

### (155) Phenolic Rich Pawpaw Extract Fraction Is Cytotoxic to Carcinomic Human Alveolar Basal Epithelial Cell Line A549

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Pawpaw (*Asimina triloba*), a deciduous species of the eastern U.S., bears the largest edible fruit of all indigenous woody species. Pawpaw fruit, rich in phenolic and antioxidant components as well as essential amino acid, vitamins, and minerals, has also been identified as a major source of a group of anticancer compounds, acetogenins. The objective of the study was to investigate the cytotoxicity of lyophilized pawpaw extract and phenolic rich fraction with a lung cancer cell line. Extracts used in this study include the whole extract (W), Fraction 2 (F2), and Fraction 5 (F5). Brine shrimp assay and cell proliferation assay were performed to assess toxicity of these extracts. Pawpaw pulp was extracted with 100% acetone twice, and then lyophilized. Acetonic (AcOH) extract was first made with fruit pulp of popular pawpaw cultivars 'NC-1' and 'Overleese', which was lyophilized and then reconstituted with double distilled water (DDH<sub>2</sub>O), followed by fractionation with different solvents in the order of DDH<sub>2</sub>O, 50% methanol (MeOH), 100% MeOH, 100% AcOH and 50% AcOH. Fractioned extracts were lyophilized again and phenolic content (PC) and antioxidant capacity (AC) were estimated with Folin-Ciocalteu assay and ferric reducing/antioxidant power (FRAP) assay. Both AC and PC of F5 were found significantly greater than that of either whole extract or F2. Cytotoxicity of pawpaw extracts were assessed by cell proliferation assay with carcinomic human alveolar basal epithelial cells (A549). While cytotoxicity of whole pawpaw extracts against A549 cells was modest, F5, the phenolic rich fraction showed considerable toxicity to this cell line. The present findings suggest that the possible usefulness of this phenolic rich fraction in cancer treatment regimen.

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### (156) Enhancement of Health-promoting Bioactivity in Broccoli Florets by Increasing Levels of Selenium and Indolyl Glucosinolates

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Broccoli (*Brassica oleracea* L. ssp. *Italica*) is a rich source of glucosinolates, phytochemicals that are hydrolyzed into isothiocyanates with known human anti-carcinogenic bioactivity. Increasing dietary intake of the element selenium (Se) also has been shown to reduce the risk of cancer. Previous research reported that Se fertilization at high concentrations reduces the concentration of glucoraphanin, the glucosinolate precursor of sulforaphane, an isothiocyanate known to upregulate genes in mammals associated with detoxification of dietary carcinogens. This research reports on simultaneous enhancement of both Se and glucosinolate concentrations in broccoli floret tissue. Methy jasmonate (MeJA) is known elicitor, active in increasing concentrations of indolyl glucosinolates and phenolic compounds in *Brassica* species. Five broccoli genotypes were subjected to root fertilization with solutions of Na<sub>2</sub>SeO<sub>4</sub> and MeJA sprays to aerial portions of the plants at floral initiation and 4 days prior to harvest of the head, respectively. Two different levels of Se fertilization (32 and 982 mg/L of Na<sub>2</sub>SeO<sub>4</sub>) increased the concentration of Se in floret tissues across five genotypes from 3.0 (control) to 36.0 µg/g and to 520.3 µg/g, respectively. The low level of Se fertilization (32 mg/L of Na<sub>2</sub>SeO<sub>4</sub>) did not influence concentrations of glucoraphanin and total glucosinolates significantly, whereas the Se treatment (982 mg/L Na<sub>2</sub>SeO<sub>4</sub>) decreased concentrations of the aliphatic glucosinolate, glucoraphanin and total glucosinolates by 34 and 8%, respectively. The low level of Se fertilization with MeJA treatment displayed no significant change of glucoraphanin concentrations with a 90 and 50% increase in indolyl and total glucosinolates concentrations, respectively. These results suggest that selenium- and glucosinolate-enriched broccoli with improved health-promoting properties can be generated by this combined treatment.

### (157) Preharvest Nitrogen Application Affects Quality and Antioxidant Status of Two Tomato Cultivars

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Intensive horticultural crop production usually has to face the problem of excessive application of fertilizer, mainly nitrogen (N). A greenhouse experiment was carried out to understand the effect of an increasing concentration of N on fruit weight and quality of two tomato cultivars (Caballero y Victoria). Nitrogen treatments were applied at concentrations of 0, 15, 30, 45 and 60 mM ranging from deficiency to toxicity. After reaching physiological maturity tomato fruits were harvested, and weight, diameter, firmness, acidity, phenols, flavonoids, and antioxidant capacity were measured. The optimal N concentration, 30mM, had the highest fruit weight, firmness and diameter on both varieties. Increasing the concentration of N to 60mM diminished weight, firmness and fruit diameter in 62, 34 and 35% for Caballero tomatoes, and 74, 43 y 40% for Victoria tomatoes, respectively. N application influenced the augmentation of acidity and soluble solids with a positive slope of  $\sim 0.5^\circ\text{Bx/mM}$  for soluble solids and  $\sim 0.007\%$  citric acid/mM for acidity ( $R^2 > 0.9$ ), on both cultivars. Phenols, flavonoids and antioxidant capacity were also affected by N application; increasing N from 30 to 60mM increased the concentration of phenolics, flavonoids, and antioxidant capacity in 50%, 125%, and 33% on Caballero, and in 60%, 95%, and 24% on Victoria tomatoes, respectively. This work points out how an improper N application affects tomato quality in terms of weight, diameter, firmness, acidity, and soluble solids; and stresses the fruit activating the defence mechanisms, causing an increase in the production of phenolics, flavonoids and antioxidant capacity.

Thursday, August 5, 2010

Springs F & G

Extension

### **(135) Developing an Extension Program for Serving the Underserved Farmers and Ranchers in Missouri: Overcoming the Many Challenges**

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Missouri had a very successful Small Farm Program that was started by Univ of Missouri Extension (UME) in 1971, and since 1976, it was run jointly by UME and the Lincoln Univ Cooperative Extension (LUCE), the state's 1890 Land-grant institution.

Because of financial exigency, the Program was closed in 2005. It was a good Program for the state's small and limited-resource farmers and ranchers, the same audience that LUCE wanted to reach. LUCE therefore decided to launch an outreach program for the benefit of this segment of the population. We were aware of the many challenges associated with starting a new extension program. Thus, we consulted with many stakeholders around the state, the 2007 Agricultural census data, and discussed our proposed plan with the target population as well as our colleagues, in order to identify and avoid all possible pitfalls. Finally, in October 2008, we launched "Innovative Small Farmers' Outreach Program (ISFOP)" with the primary objective of assisting the undeserved citizens who are trying desperately to make a living from their small acreages. ISFOP currently operates in seven counties in the East Central region and another seven counties in the West Central region of Missouri. These areas were chosen for their proximity to the state's two largest cities that offer a substantial consumer base for the locally grown commodities, as well as have large minority and new immigrant populations. Many small farmers, both urban and rural, have begun to rely on ISFOP for receiving farm-related information, technical assistance and training. In addition to sharing some of our success stories, we will discuss how we were able to change many apprehensions out there during the planning stage to a lot of "goodwill" that has made our job so rewarding.

*Specified Source(s) of Funding:* Univ

### **(136) AgTools for Managing Financial Risk in Agriculture**

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Agricultural producers often make large up-front investments in producing and establishing cropping systems, purchasing equipment, buildings or new technologies in hopes of making a reasonable return on their investment. Misjudging the costs and potential returns of such investments can result in serious financial difficulty. However, adequate compensation can come to those who have the information, develop strategies, and perform sensitivity analyzes before implementing a decision. The *AgTools™ for Managing Financial Risk in Agriculture* website hosts a suite of software programs with the aim to help agricultural crop producers make better decisions to manage the financial risk in agriculture. Currently five programs are available to U.S. agribusinesses – AgProfit™, AgLease™, Ag-Finance™, AgPlan™, and Tree Loss Calculator. Agriculture's Profitability Tool (AgProfit™) is designed to assist producers make long-run decisions by estimating machinery, building, labor, and production input costs and total yield for calculating

returns for crops with multiple establishment and production years. The program can inflate return and input cost items over time to analyze the net present value, internal rate of return, and financial feasibility. Agriculture's Crop Lease Tool (AgLease™) is designed to assist growers and landowners establish equitable crop share and cash rent lease agreements. With AgLease™ you can easily comprehend and evaluate the potential risks associated with annual and long-term leases; reevaluate current leases, or changing cropping systems. The program allows you to inflate specific return and input cost items over time to analyze the net present value, internal rate of return, and financial feasibility for a crop share and cash rent lease. Agriculture's Financial Tool (AgFinance™) is designed to assist agricultural producers make long-run decisions on a whole farm basis. You can load scenario files from AgProfit™ and AgLease™ to analyze your farm's financial ratios and performance measures, which include working capital, current, debt-to-asset, and debt-to-equity ratios, earned net worth and net worth. AgPlan™ helps rural business owners develop a business plan. It is designed to provide customized assistance to different types of businesses. Tree Loss Calculator are spreadsheets designed to calculate the economic value of a pear, apple or cherry tree lost to external factors, such as hit by a vehicle. The value of this loss is dependent upon the value of the fruit, productivity of the lost tree, and years for which a new tree to produce the same amount of fruit as the lost tree.

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

### **(137) Monsanto Vegetable Seeds Technology Development Associate (TDRA) Training Program**

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Monsanto is an agricultural company with a commitment to developing products farmers around the world can use to increase production and conserve resources. Monsanto is also dedicated to recruiting and retaining the best individuals through a team-oriented culture that encourages creativity, decision-making, and entrepreneurial spirit. In 2009, Monsanto Vegetable Seeds (MVS) launched a training program located at the Monsanto Learning Centers in Monmouth, IL and Scott, MS. The Technology Development Representative Associate (TDRA) Program is designed to help Ph.D. and M.S. degree scientists gain working knowledge of Monsanto's Technology Development (TD) organization and hands-on experience in both vegetable and row crops. The program features six important areas: mentoring and training, research, protocol and processes, building networks, demonstration, and community service. The TDRA program, which varies from 6-18 months, is tailored to fit each individual's background and skill set. The program prepares TDRA's for a Technology Development Representative (TDR) role and other

future positions within Monsanto. The MVS TDRA Program demonstrates Monsanto's commitment to developing the careers of its employees.

### **(138) Building Capacity for Florida's Small Farm Specialty Crop Industry with a Statewide Conference**

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Consumer interest and demand for local foods has changed the dynamic of the Florida small farms industry from a little-known group of clientele to a larger and more diverse clientele group that actively participates in Univ of Florida (UF) extension programming, on-farm research, local and state policy discussions, and partnership building. Based on the USDA definition, well over 90% of the over 47,000 farms in Florida are small farms. Florida reported an 8% increase in farm numbers from 2002 to 2007, essentially all in the small farm category. According to the 2007 US Ag Census, 89% of the Florida farms report less than \$100,000 in product sales. The other common characteristic of these operations is they are family-oriented farms dependent upon the family for management and labor. Extension programs can make a difference by providing educational information to help small farmers successfully start their farming operations or adopt new alternative enterprises. Current barriers include: access to markets, regulations, labor, locating materials, and supplies, size-appropriate production, technologies, and adoption of sustainable practices. The UF-IFAS Small Farms and Alternative Enterprises Focus Team consists of over 80 state and county faculty that self-affiliate with the extension programming of this team. Based on results of a statewide small farm survey, written evaluations from clientele attending county and regional programs, and informal discussions with stakeholders, industry partners and community organizations, a Stakeholder Planning Committee of 30 volunteer members was assembled in 2007 to plan the first statewide conference for small farmers. The two-year planning period and support from IFAS's Office of Conferences and Institutes was essential to our success. The result was a two-day event that included a large trade show with over 80 exhibitors, a live animal educational demonstration area, a keynote address, innovative farmer awards, six concurrent sessions including tracts in horticulture, alternative energy, alternative enterprises, policy & regulations, organic & sustainable farming, livestock, and business & marketing. Food featuring products from Florida small farms comprised refreshment breaks

and lunches. The majority of the 800 attendees responded in a post-event evaluation that the networking was as equally valuable as the educational content. A second statewide conference will be held in July 2010. Although strong partnerships have been developed with community-based organizations, institutional partnerships with Universities, FDACS, Farm Bureau, Farm Credit, and various USDA agencies will need to be strengthened to better serve the needs of small farmers.

*Specified Source(s) of Funding:* Florida Department of Agriculture and Consumer Services, Southern Region SARE, USDA Risk Management Agency, Univ of Florida-IFAS

### **(139) An On-Farm Demonstration and Consultation Extension Program in Kentucky**

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The Kentucky Horticulture Council, a consortium of 13 industry and professional associations, was established in 1991 to represent and foster support for the various segments of Kentucky horticulture. In collaboration with the Univ of Kentucky's Horticulture program, a comprehensive strategic plan for the industry was created in the early 1990s and updated every two years. When 50% of the Master Tobacco Settlement awarded to Kentucky was dedicated to the Kentucky Agricultural Development Fund, a portion of KY horticulture industry's strategic plan was funded. Since 2002, more than \$5.8 million have been awarded to UK Horticulture for on-farm demonstration/consultation, field research plots on our three research farms, and market research and education. The grant funded six Extension Associates in 2002 strategically located across the state, increasing to nine in 2004, to conduct on-farm demonstrations of horticultural production/marketing systems. A primary audience has been farm families who had depended on the income from tobacco. The program has been extraordinarily successful with Extension Associates hired to multiply faculty impact, supporting an 8 to 10% per year industry growth until the recent economic down turn. The program details have changed over the years with changing economic conditions and shifting markets but the delivery methods have continued to succeed. In 2009 alone, the Extension Associates conducted 53 on-farm demonstrations and 1,850 on-farm and/or face-to-face visits (4,949 hours), requiring an additional investment of 4,114 hours in planning, establishing and maintaining on-farm plots (plus nine strategic on-farm research plots managed by the Extension Associates)

and 1,678 hours in problem solving. Fifteen field days and farm tours multiplied the impact of the demonstrations in communities. In 2009, the Extension Associates logged more than 4,200 phone calls and 15,000 emails (5,800 to individuals and 9,200 to targeted distribution lists) in support of these programs. Workshops and other presentations (117) reached a variety of audiences (5,077 total attendees) with pre-season and in-season information specific to crop production protocols and marketing opportunities. Extension Associates have also multiplied their impact by securing more than \$125,000 in extramural support for their programs. The vast majority (90% as of 2008) of farm families participating in the on-farm demonstrations are still producing horticultural crops.

### **(140) Communicating Integrated Pest Management in the 21st Century**

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Integrated Pest Management (IPM) is a science-based decision-making process that identifies and reduces risk from pests and pest management strategies. IPM evaluates pest biology, environment and all available control methods in developing cost effective and environmentally safe pest management practices. Although the origins of IPM can be traced to production agriculture, the concept is an effective strategy for managing pests in all settings. The IPM concept has been widely adopted in the production of food and fiber. High input costs and tight profit margins are often the motivators facilitating adoption. Commercial nursery production and home horticulture, where pest tolerance is low or even zero, have been much slower at adopting IPM practices even though the information is widely available. However, recent changes in consumer preferences favoring greener production practices may finally trigger improvement in IPM adoption. Rapidly changing advances in technology are providing consumers with tools to make informed purchases. For example, Radio Frequency Identification (RFID) chips could enable consumers to quickly and easily track an apple from blossom to the store shelf. This is powerful information for consumers looking to make greener choices. Unfortunately, on the other end of the spectrum, consumers are able to access mobile content via wireless handheld devices, advising them to steer clear of certain products due to biased and often unscientific claims. Reaching consumers and often less organized horticultural industry groups with science based IPM information won't happen through traditional Extension bulletins and meetings. In realizing this challenge, the Univ of Wisconsin IPM Program has been investigating new methods for information delivery. One method that has proven highly successful is utilization of the Univ of Wisconsin Cooperative Extension YouTube Channel to post pest management videos created during the growing season. Short duration videos, up to 15 minutes in length highlighting pest identification, biology and control options have received many views. This video format is particularly useful for dissemination of information in response to quickly emerging pest problems as was the case

with tomato late blight in 2009. Currently, we are experimenting with providing mobile content IPM information. From field scouts accessing pest identification to consumers making informed purchases, the ability to place science based information, literally in the hands of our clientele, when and where it is needed most, is a goal worth pursuing.

### **(141) Opportunities for Researcher Involvement in Extension Gardens, Lawns and Landscapes**

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The Cooperative Extension Service has developed a platform called eXtension (pronounced e-extension) that interlinks personnel at land grant institutions and provides tools for disseminating Web-based and other digital information. Initial work in eXtension has concentrated on building communities of practice that interact to develop on-line content and provide information resources to clientele. Most often it is Extension personnel, or those with a partial Extension appointment, who have engaged in eXtension. However, as eXtension expands there are opportunities for researcher involvement as well. For example, researchers may wish to provide press releases or synopses of their work to be posted on eXtension. This will allow increased access to scientific information by the public and will promote increased visibility of the researcher, their program, and institution. Researchers may also wish to help develop educational materials or provide critical reviews of such material to help ensure that information provided to the public is accurate and relevant. Finally, researchers may wish to engage in eXtension communities of practice to network with colleagues on the national level and to engage eXtension communities of interests (clients) to ensure that their mission-based research is addressing pertinent needs. This paper will provide examples of researcher involvement in eXtension and address ways that horticulture researchers might become involved in eXtension Gardens, Lawns and Landscapes.

*Specified Source(s) of Funding:* eXtension Initiative

### **(142) Extension Ask an Expert—A Convenient Tool for State and Local Extension Programs**

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The Cooperative Extension Service has developed a platform called eXtension (pronounced e-extension) that interlinks personnel at land grant institutions and provides tools for disseminating Web-based and other digital information. One component of eXtension is the Ask an Expert application. Ask an Expert allows clients to post a question through a simple Web form. The question is routed to an expert (Extension staff or

Extension Master Gardener volunteer) who answers the question and the answer is routed back to the client through an email message. Questions and answers may be added to a growing database of frequently asked questions. The Gardens, Lawns and Landscapes section of www.eXtension.org, hosted by the Consumer Horticulture community of practice, answered over 5,500 incoming questions through Ask an Expert in 2009. This corresponded to ~40% of the total questions answered through eXtension Ask an Expert. An Ask an Expert widget is also now available that allows local Extension staff to receive questions directly from local clientele. This paper will describe some of the features of both Ask an Expert and the Ask an Expert widget, and discuss the possible uses of these tools by local Extension staff.

*Specified Source(s) of Funding:* eXtension Initiative

### **(143) Whitefly Pest Control Survey of Homeowners and Ornamental Plants**

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Sweetpotato Whitefly, *Bemisia tabaci* is a major pest of both ornamental and agricultural crops in Arizona. They cause injury such as leaf curl, sooty mold as well as transmit viruses that cause plant death. A recent whitefly dispersal study, conducted in Yuma County, reemphasized that whiteflies are considered major pests between June and October. Average whitefly trap counts for this time in 2008 was 1000 per trap and for 2009 1500 per trap. A comparison of populations between the City of Yuma and surrounding agricultural areas found that agriculture in the western regions of Yuma influenced whitefly populations immediately adjacent to the city (Bealmear, unpublished 2009). This interaction in urban whitefly dispersal leads to questions about their management. A survey of pesticides used in Arizona agriculture was done when the efficacy of pyrethroid insecticides began to diminish in 1995. Similar chemistries are available for ornamental plants but were not included in this survey leaving questions as to which products are being used to control whiteflies on ornamental plants. In February and March of 2010 a statewide survey was administered to home gardeners to determine which whitefly control products are in use. Two hundred and seventy nine people, mostly homeowners, responded to the survey. Sixty seven percent indicated that they do have whitefly problems. Eighty two percent of these indicated the worst problems were on garden and landscape plants. The majority, sixty eight percent responded they do nothing to control whiteflies. Only six percent used pesticides and of those that used pesticides ten percent used products such as malathion, ortho, specticide and sevin. Fourteen percent used biorational products like garden safe, pyrethrins and *Bacillus thuringiensis*. These results show that whiteflies are a major pest the majority of homeowners do not manage them.

*Specified Source(s) of Funding:* The Arizona Department of Agriculture Specialty Crops Block Grant



## (144) The Instant Survey at the Great Plains Vegetable Growers Conference

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The Great Plains Vegetable Growers Conference (GPVGC) takes place in the 2<sup>nd</sup> weekend of January each year at St. Joseph, MO. It has been the largest vegetable conference in the Great Plains. At the 2010 conference, an instant survey was conducted the very first time to evaluate the conference and picture the attendees. Among the participants, 44% of them came from Missouri, 29% from Kansas and 10% from Nebraska; 60% of them were commercial vegetable growers, 14% were educators, 25% were home gardeners or community gardeners. It also indicates that the majority producers were in the 40-60 age group, about 70% of them were male, and 25% of them have been growing vegetables for over 10 years. Around 70% of producers grow less than 10 acres of vegetables and only 7% had more than 20 acres. Half of the growers sold their produce at Farmers' markets and others sold them through CSAs or grocery stores. Most growers may have another job, as indicated by the percentage of income resulted from vegetable/fruit sales and by the fact most of sales were less than \$25,000. About half of the participating farmers practiced organic production and half of them had one or more high tunnels. Most participants were optimistic about vegetable production in the future, a quarter them have been with the GPVGC for over 5 years and stated that they learn a lot from the conference. The overall response was very positive about the conference. The survey results will be valuable for the organizing committee, extension educators and producers.

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## Floriculture

### (307) Observations from the University of Florida Fort Lauderdale Trial Garden

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The Univ of Florida trial garden at the Fort Lauderdale Research and Education Center began in 2002 to develop unbiased evaluations of vegetatively propagated annual bedding plant cultivars. Now in its eighth year, we have trialed species for Ball, Fischer/Goldsmith, Danziger, Fides, Henry F Michell Co., and Euro American Proven Winners. Originally, the garden started by trialing geranium and New Guinea impatiens cutlivers but has grown to include a wide variety of plant material. In addition to monitoring plant growth and performance, each year a consumer preference survey is conducted where participants are

asked to selected all cultivars that they like. These selections are ranked using Proc Rank in SAS and then the rankings are analyzed using ANOVA. Those cultivars that were highly ranked also grew better in the garden. Over the past 7 years we have trialed 55 different genera in 20 different families. In general, plants in the Asteraceae performed very well while plants in the Scrophulariaceae did not perform well.

*Specified Source(s) of Funding:* state funds

### (308) Cool Night Temperatures Stimulate Floral Initiation in Tall Bearded Iris

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*Iris germanica* (tall bearded iris) have long been used in the cut flower industry. In 2008 iris stems accounted for \$19.9 million of the \$403 million reported of the 15 state total. This could be increased if reblooming (remontant) iris could be scheduled to bloom over an extended season. In 2009, studies were conducted to examine the low temperature effects on flower initiation in reblooming ('Immortality') and spring blooming ('Arctic Fox') tall bearded iris. Twelve rhizomes per treatment, per cultivar, were potted in Sunshine Mix 1 in 15cm containers and grown in a >25 °C (day/night) greenhouse for 2 weeks until well rooted. Plants were treated with 0, 3, 6, 9, 12, 15, 18, or 21 cool nights (<20 °C) before being returned to a warm greenhouse (>25 °C). Six plants were destructively harvested from each treatment, by extracting the meristems to examine floral initiation histologically at 0, 3, or 6 days after completing cool night temperatures. The six remaining plants were grown until either flowering or the termination of the study on 11 Dec. 2009. Data collected included date of first floret opening, number of florets, stem length, and leaf number. Reblooming iris 'Immortality' and spring blooming 'Arctic Fox' initiated floral meristems after receiving a minimum of 9 nights below 20 °C with days above 25 °C. Only 'Immortality' developed flowers to anthesis, however, there was no significant effect of number of cool nights on floral development. Conversely, there were significantly greater number of florets and longer stem lengths in the 21 cool night treatment compared to the 3, 6, or 15 cool night treatments. When comparing leaf number, the 21 cool night treatment had greater number of leaves per plant compared to the 3 and 6 cool night treatment. Although there was no correlation between floral development and number of cool nights in 'Immortality', the trend in differences between treatments stayed in the same order regardless of independent variable (number of florets, stem length, and leaf number) sug-

gesting there may be a narrow window where the number of cool nights governs floral initiation and development.

### (309) Herbaceous Peony Trials for Cut Flower Export in Alaska

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Research was begun in 2001 to identify all components of peony field cut flower production and distribution from field selection and planting to post harvest handling and packaging for export. This experiment evaluated three components of this process: seasonal planting times, root characteristics, and post harvest handling of cut stems. In a comparison of planting times (direct field planting in autumn, direct field planting in spring or as containerized plants in mid summer), 'Sarah Bernhardt' and 'Felix Crouse' showed no difference in shoot number and growth one full year after planting. 'Duchess de Nemours' and 'Alexander Fleming' showed significant reductions in growth compared to the other cultivars, and we suspect disease and early bud break as contributing factors. All treatments where bud break had occurred in storage with 'Duchess de Nemours' and 'Alexander Fleming', new shoots rotted, and recovery was slow. One year following planting, total number of stems and number of flowering stems differed significantly among cultivars. Containerized plants showed significantly fewer flowers in year one for 'Sarah Bernhardt' and 'Felix Crouse'. 'Sarah Bernhardt' roots and crown buds were weighed, counted and measured (length, diameter) prior to planting in order to learn if a correlation exists between root characteristics and subsequent growth and flowering. Three root attributes were correlated with the total number of stems produced in year one: total number of eyes per plant, total number of roots per plant and root fresh weight. Root length and maximum diameter were not correlated with subsequent growth. In addition, we found no relationship between any root characteristics and number of flowering stems and foliage height in the first year. Best methods of handling peony cut flowers for greatest vase life include cutting peonies dry in the field and storing them dry in a cooler (34°F) at 80+% relative humidity until shipping. Use of water in buckets in the field or pulsing flowers with water in the cooler does not improve vase life of peonies. Under optimum conditions, 'Sarah Bernhardt' peonies lasted up to 15 days in a vase, 8-9 days from bud break to full bloom and an additional 5-7 days in full bloom. Unchilled stems reached full bloom in 3-4 days with 8-9 days at full bloom. Chilling slowed bud opening but did not influence length of full bloom.

*Specified Source(s) of Funding:* USDA National Institute of Food and Agriculture, New Crops Grant

### (310) Daily Water Requirements of Poinsettias as a Function of Plant Age and Environmental Conditions

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Efficient irrigation in greenhouses is critical in ornamental plant production to assure plant quality and minimize leaching and runoff. However, information on water needs of potted plants is limited. The goal of this study was to quantify the effects of plant age and environmental factors on water use. Two poinsettia cultivars (*Euphorbia pulcherrima* 'Prestige Red' and 'Strawberries 'N Cream') were grown in three different size pots (diameters = 12.5, 15, or 20 cm) for 16 weeks to quantify their daily water use. We used a soil moisture sensor-based automated irrigation system to maintain a substrate water content of  $0.4 \text{ m}^3 \cdot \text{m}^{-3}$  throughout the growing period. Daily water use and environmental factors such as daily light integral (DLI), temperature, relative humidity, and vapor pressure deficit (VPD) were recorded. Plants of both cultivars used little water (0-10 mL) on days that DLI was low ( $< 5 \text{ mol} \cdot \text{m}^{-2} \cdot \text{day}^{-1}$ ). The maximum daily water use of 'Prestige' was 106, 112, and 158 mL and that of 'Strawberries 'N Cream' was 57, 93, and 147 mL in 12.5-, 15-, and 20-cm pots, respectively. Poinsettias generally used the most water when DLI was high ( $> 25 \text{ mol} \cdot \text{m}^{-2} \cdot \text{day}^{-1}$ ). Cumulative water use for the 100-d growing period was 4.5, 4.7, 5.7 L for 'Prestige' and 2.2, 2.9, and 4.7 L for 'Strawberries 'N Cream' in 12.5-, 15-, and 20-cm pots, respectively. Throughout the growing period, DLI and VPD were the most important environmental factors affecting the daily water use of poinsettias. Models predicting daily water use based on plant age and environmental conditions may be useful in predicting irrigation requirements of poinsettias. This in turn would reduce water use and reduce leaching and runoff of nutrient-rich water from greenhouses.

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### (311) Wyoming Perspective on Cut Flower Production

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A series of simple feasibility studies have been conducted at the Univ of Wyoming regarding production of various fresh cut flower crops in our climate. Snapdragons (*Antirrhinum majus* L.), callas

(*Zantedeschia aethiopica* L. Spreng), and orchids (*Cymbidium* spp.) were grown to assess opportunities for production in Wyoming. All were grown in a polycarbonate-covered greenhouse at 13 °C night/21 °C day temperatures at 2,376 meters altitude in Laramie, Wyoming. Callas and orchids were planted in 7 L containers placed on 61 cm centers while snapdragons were grown in 2.4 L containers pot-to-pot. Callas and snapdragons were planted in a commercial mix containing coconut coir, perlite, and vermiculite; orchids were grown in a commercial orchid medium consisting of bark, peat moss, and perlite. All plants were watered as needed and were fertilized using a 15N-3.9P-10.0K slow-release fertilizer. Callas produced flowers almost continuously throughout the year. Production averaged 5.4 flowers/m<sup>2</sup> per week. *Cymbidium* orchids flowered in the fall months, as they are long-night plants. Production averaged 1 spike/m<sup>2</sup> per week over 3 months. Snapdragons were grown from September through December and in 3 months produced an average of 3.6 stems/m<sup>2</sup> per week with harvest concentrated in the last 4 weeks of the study period. These flowers can be grown for the fresh cut market in Wyoming.

*Specified Source(s) of Funding:* Internal sources

### **(312) Storage and Vase Life of Cut Rose Flowers as Influenced by Various Packing Materials and Chemicals**

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This experiment revealed significant influence of sucrose, glucose and silver nitrate ( $\text{AgNO}_3$ ) at different concentrations on the vase life of six (tropicana, peace, iceberg, eurpeana, strike it rich and double delight) roses (*Rosa hybrida* L.). It was found that different treatments had significant effect on each cultivar. The cultivars, tropicana, double delight and iceberg, excelled over others in all the treatments studied. Furthermore silver nitrate, in most of the cases, gave better performance than the sucrose in enhancing the shelf life of cut flowers of most of the cultivars. The concentration of sucrose @25 g L<sup>-1</sup> superseded over the other sucrose concentrations with the value of 7.1 days in 'tropicana' and 6.4 days in 'iceberg' comparing the control (distilled water) with the average value of 4.2 days. In all the treatments containing sucrose, glucose and silver nitrate, the concentration of 150 ppm of  $\text{AgNO}_3$  prolonged the maximum number of days as compared to control. The influence of various packing materials, viz. cellophane paper, butter paper and aluminum lamination foil, on the storage and vase life of cut rose flowers (*Rosa hybrida* L. cvs. tropicana, peace, iceberg, eurpeana, strike it rich and double delight) was studied. Flowers were harvested at two different stages, viz. tight bud stage and loose bud stage. Data regarding storage life (days) and vase life (days) of flowers of all the treatments were collected by

following standard procedures. When flowers of cv. 'tropicana' were kept in aluminum lamination foil at tight bud stage, both storage and vase life were maximum followed by cv. 'iceberg' in the same packing material. Cultivar 'double delight' harvested at loose bud stage and placed in cellophane paper exhibited minimum storage and vase life. Flowers should be harvested at tight bud stage and packed in aluminum lamination foil for prolonging their shelf life.

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### **(313) Benzyladenine Application Increased Basal Shoot Production in Four Echinacea Cultivars**

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The objective of this study was to quantify the influence of benzyladenine (BA) application on basal shoot production in 'After Midnight', 'Harvest Moon', 'Sunrise', and 'Magnus' echinacea. Liners of the four echinacea cultivars were transplanted in 15-cm containers in a peat-based medium. Plants received a single foliar application of BA at 0, 300, 600, or 900 mg·L<sup>-1</sup> at transplant or 3 weeks thereafter. Ten plants per treatment were arbitrarily placed on greenhouse benches and grown in a polycarbonate greenhouse under a 16-h photoperiod. The mean daily temperature and daily light integral during the experiment were 24.1±0.6 °C and 10.6±0.6 mol·m<sup>-2</sup>·d<sup>-1</sup>, respectively. The number of basal shoots was counted at 0, 3, 6, and 9 weeks after treatment (WAT) and percentage increase in basal shoots at 3-week intervals was computed. Data were analyzed as repeated measurements in SAS's PROC MIXED and pair-wise treatment comparisons were made using LSD at  $P \leq 0.05$ . Compared with the controls, the BA treatments resulted in significantly higher percentage increase in basal shoots at 3 WAT, with no subsequent increase at 6 or 9 WAT. BA application at transplant generally elicited a greater percentage increase in basal shoots compared with BA application 3 weeks after transplant. In 'After Midnight', percentage increase in basal shoots was the greatest when BA was applied at 600 mg·L<sup>-1</sup> whereas; all the tested BA rates were similarly effective in increasing basal shoot production in the other three cultivars. Compared with the controls, 'After Midnight', 'Harvest Moon', 'Sunrise', and 'Magnus' treated with BA at 600 mg·L<sup>-1</sup> at transplant had 200%, 62%, 135%, and 148% more basal shoots, respectively. Based on these results, we recommend a BA application at 600 mg·L<sup>-1</sup> at transplant to increase basal shoot production in echinacea.

### (314) Effect of Pot Size and Abscisic Acid Rate on Time to Leaf Wilt for Flowering New Guinea Impatiens

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Recently, abscisic acid (ABA) spray treatments up to 100 mg L<sup>-1</sup> were found to delay leaf wilting of New Guinea Impatiens that can occur due to water deficit stress during postharvest handling. However, this effect was not uniform across the cultivars studied. In the present study, we evaluated the effect of rates up to 2000 mg L<sup>-1</sup> and pot size on the time from application to leaf wilt for New Guinea Impatiens. In the first experiment, plants of two cultivars at commercial maturity in 15 cm pots were sprayed to runoff with 0, 100, 500, 1000, and 2000 mg L<sup>-1</sup> ABA. In a second experiment, plants of one cultivar were grown in either 10 or 15 cm pots and sprayed as in the first experiment. Plants in both size pots were potted at the same time and reached commercial maturity at the same time. The plants in the 10 cm pots were observed to be in a more root bound condition than the plants in the 15 cm pots at the time of application. All plants from both experiments were watered thoroughly just prior to application. After the spray applications, the foliage was allowed to dry. The plants were then held at 20°C for evaluation of treatment responses. For the first experiment, the time to wilt increased significantly with rate regardless of cultivar up to 500 mg L<sup>-1</sup>. This treatment doubled the time to wilt when comparing it to the control. There was very little additional benefit for rates higher than 500 mg L<sup>-1</sup>. For the second experiment, plants in 10 cm pots wilted 3.5 days earlier than plants in the 15 cm pots. The response to ABA rate was similar to the first experiment. Plants grown in smaller pots or in a root bound condition may require higher rates of ABA to produce the same delay in wilting seen for plants in larger pots.

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### (315) Acidification of Soilless Substrate by 13 Floricultural Crops

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Impacts on substrate pH by 13 major floricultural crops fertil-

ized with a neutral fertilizer were evaluated. Plants were grown for 78 days in 16.5 cm diameter (1.8L) plastic pots filled with 3 sphagnum peat moss: 1 perlite (v:v) substrate amended with CaCO<sub>3</sub> powder to establish an initial target pH of 6.5. Plants were watered with deionized water upon transplanting. Beginning with the second irrigation at 4 DAT, a neutral 17N-2.2P-14.1K fertilizer dissolved in deionized water was applied with each irrigation at 100 or 200 mg·L<sup>-1</sup> N. Substrate pH was monitored and ΔpH, the difference between initial pH measured 4 DAT and final pH measured 78 DAT, was used to determine the acidification levels of crops. Petunia (ΔpH=0.14), begonia (0.19), and osteospermum (0.43) were very light acidifier-species (ΔpH <0.5). Pansy (ΔpH=0.51), impatiens (0.79), New Guinea impatiens (0.89), and geranium (0.97) were light acidifier-species (ΔpH=0.5-1.0). Vinca (ΔpH=1.00), tomato (1.17), and Reiger begonia (1.46) were medium acidifier-species (ΔpH=1.0-1.5). Pot mum (ΔpH=1.56), sunflower (2.44), and kalanchoe (2.45) were heavy acidifier-species (ΔpH=1.50-2.50). However, the former three acidification groups of plants were fertilized at the rate of 100 mg·L<sup>-1</sup> N while this final fourth group was fertilized with 200 mg·L<sup>-1</sup> N to comply with fertilization recommendations. Overall, substrate pH declined rapidly for the initial 24 days in all crops. Plant nutrient uptake effect on substrate was probably minimal due to low biomass during this initial period allowing the acidic fertilizer solution (pH 4.6-4.8) to have the predominant effect. After 25 DAT the physiological pH effect of nutrient uptake from the neutral fertilizer became more important due to rapid plant growth. During the post 25 DAT period, pH effects of species were clearly seen. Begonia and petunia caused a rise in substrate pH from 6.4 and 6.2 to 6.7, respectively while pH remained essentially constant for osteospermum. The net pH effect in the light and medium acidifier crops was a decline, but there was a substrate pH plateau after 39 DAT for New Guinea impatiens and pansy and a similar plateau between 24 and 55 DAT for tomato and vinca. The rapid pH decline after 25 DAT for the heavy acidifier crops could be due in large part to the higher 200 mg·L<sup>-1</sup> N fertilizer concentration.

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### (316) Effects of Temperature on Poinsettia Production

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Because of higher fuel prices and low production margins, poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzsch) growers are becoming more interested in growing at cooler temperatures for energy-saving benefits; however, quantitative data on plant growth and development of poinsettia cultivars grown under lower temperatures throughout production is lacking. The objective of this study was to evaluate forty trial poinsettia cultivars from Syngenta Flowers and Paul Ecke Ranch grown in separate greenhouses at temperatures of 65 °F (18–19 °C) during the day and 60 °F (15–16 °C) at night for cold production, or 75 °F (23–24 °C) during the day and 70 °F (21–22 °C)

at night for warm production. The experiment was conducted at the Oklahoma State Univ Research Greenhouses starting in August 2009. Data was collected on number of cyathiums, number of inflorescences, number of bracts, plant height, plant width, and stem diameter in December 2009. There was a significant difference ( $P=0.05$ ) among the interaction between cultivars and greenhouse temperatures for all measured traits for both production systems. Cultivar and temperature combinations that optimized each trait were determined. Poinsettia cultivars with the largest stem diameter in both warm and cold production included '39-02B', '7-07', 'Classic White', and 'Enduring Red'. Poinsettia cultivar 'HC-18B' was the only one in the group for highest number of bracts and number of cyathiums in both warm and cold production. Only one cultivar, '1266', had the most number of inflorescences, and no cultivars were found with the most height or width in both production systems.

*Specified Source(s) of Funding:* Poinsettia cuttings were donated from Paul Ecke Ranch and Syngenta Flowers, Inc.

### **(317) Deferring Flowering of Two Hybrid Nobile Dendrobium Cultivars by Holding Plants under Low Temperature after Vernalization**

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Very few studies have been done to make the year-round greenhouse production of dendrobium orchids possible. This experiment was part of a study to develop a strategy to defer flowering of nobile dendrobium orchids by holding them under low temperature after vernalization. In Sept. 2008, mature *Dendrobium* Red Emperor 'Prince' and *Dendrobium* Sea Mary 'Snow King' plants in 10-cm pots were held in 10 °C growth chambers for various durations after 4 weeks of vernalization. Treatments consisted of five durations of low temperature holding (0, 4, 8, 12, and 16 weeks). Following treatment, plants were moved to a greenhouse. Time to anthesis, node differentiation (including number of flowering nodes, aerial shoots and aborted buds) and flower quality (including flower number, flower diameter, flower number per flowering node, and postharvest flower longevity) were recorded. For both cultivars, with the increase of duration of holding in low temperature, plants needed longer time to reach anthesis from the beginning of low temperature treatment; however, the time to anthesis decreased when the low temperature treatment duration was excluded. Various durations of low temperature holding did not affect the percentage of flowering nodes, aerial shoots or aborted buds for both cultivars. Longer

low temperature holding durations resulted in larger flowers in Red Emperor 'Prince' but at the same time caused a decrease in the flower number per flowering node for both cultivars. Most flower quality parameters of Sea Mary 'Snow King' were not affected by longer low temperature holding durations. Especially, the postharvest flower longevity was not adversely affected by various durations of low temperature treatment, which could make low temperature holding be used commercially to extend the marketing time without reducing the quality of the flowers. However, our data showed that the longer the plants were held in low temperature, the more leaves abscised. This is a potential detrimental effect of low temperature holding.

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### **(318) Effects of Elevated CO<sub>2</sub> and Suboptimal Temperatures on Plant Development, Nutrient Uptake, and Insect Performance**

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Reducing temperatures during plant production will result in greenhouse energy savings; however, lower temperatures may lengthen the crop production time. Using elevated CO<sub>2</sub> concentrations could help plants compensate for the reduction in growth. The goal of this experiment was to evaluate suboptimal temperatures and elevated CO<sub>2</sub> as an alternative to reduce heating energy costs. Effects of elevated Genetics/Germplasm/Plant Breeding: Biotechnology 2 and suboptimal temperatures on plant development, nutrient uptake, and insect behavior were evaluated in a growth chamber study. Zinnias (*Zinnia elegans*) and petunias (*Petunia x hybrida*) were germinated in trays and transplanted to 6 inch pots. After transplanting, plants were grown using optimal (21 °C) or suboptimal (18 °C) temperature, ambient (390 μl·l<sup>-1</sup>) or elevated (800 μl·l<sup>-1</sup>) Genetics/Germplasm/Plant Breeding: Biotechnology 2, optimum or high nutrient levels, and presence or absence of insects. Flowering time and flower longevity were used to evaluate plant development. Concentrations of micro and micronutrients in leaves, stems and flowers were analyzed. Three weeks after transplanting, half of the plants were infested with whiteflies (*Bemisia tabaci*) to investigate the effect of Genetics/Germplasm/Plant Breeding: Biotechnology 2 and temperature on oviposition. Overall, results showed that total dry weight of petunias and zinnias was affected by nutrition levels and suboptimal temperature. Plants treated with high nutrition level had 35% greater biomass compared to those treated with optimum level. Zinnias grown at suboptimal temperature and ambient CO<sub>2</sub> were taller, whereas petunias were shorter. Presence of insects did not result in any change of plant height or dry weight at any of the temperatures or CO<sub>2</sub> regimes. Nevertheless, the presence of whiteflies caused earlier flowering in plants grown at the suboptimal temperature compared to those grown at optimal temperature. Generally, plants grown at optimal temperatures bloomed earlier and had shorter flowering duration, 5.1 days less than plants grown at

suboptimal temperature, regardless of nutrition and crop type. Nutrient concentrations in various plant parts varied; although, most significant results showed a reduction in accumulation of nutrients at lower temperature. Whitefly oviposition was lower in petunias than zinnias. Results showed that the temperature and/or CO<sub>2</sub> treatments did not affect whitefly oviposition. These partial results show that suboptimal temperatures and CO<sub>2</sub> enrichment influence plant quality and production time, so care must be taken if this strategy is utilized to help decrease energy costs.

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### (319) Study on Potential Production of Lotus in Thailand

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There are many marsh areas in Thailand where some are swamps that are suitable for lotus farming especially in Budhamontol District in Nakornpatom province. It was recognized as one of the most important lotus farm in Thailand. From the survey research most farmers who grow lotus are men with average age of 43.4 years. The lotus farm areas are 18.08 rais (7.232 acres) per person in average. Most of the areas are used to be rice farm and are rented. Better income is the reason for farmers who change from rice farm to lotus farm. About 62.86 % of the farmers used their own financial cost for their lotus farm. Lotus farm begins with the preparation of lotus pond by plowing off the land surface, leaving the pond to be dried out, putting in bio fertilizers and then getting water into the pond about 15 centimeters height from the bottom. Farmers will transplant the lotus rhizomes in the pond which is called covered with soil method. The popular varieties Lotus rhizomes is Sattabankacha. Farmers who grow the lotus will start in summer during February–March because the plant will grow up very well and will be harvested from May onward. At the age of 3–4 months or when the lotus yield less products farmers will plough over the stems and rhizomes to be buried in the soil and let the rhizomes to sprout up. Farmers will put in fertilizers to the lotus farm at 50 kilograms per rai every 20 – 30 days. To get rid of plant insects the farmers will spray insecticides every 2 weeks. The products from lotus farm are lotus flowers, young and old berry like fruits but mostly are flowers. Lotus flowers for sale that suit the need of the market should be at the age of 2 months. Harvesting of lotus products will be accounted for 207.14 bundles (bundle with 10 flowers) on average a day. Most farmers will sell their products by themselves at Pak klontalad. Some has sent their product to Singapore. The net income is about 1,028.25 baht per day. In addition, for export,

which is another way of marketing, only a few farmers could do by themselves due to the lack of knowledge in international market. They have to depend upon the middleman and exporter for other flowers such as orchid

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Springs F & G

## Genetics/Germplasm/Plant Breeding: Biotechnology 2

### (064) Characteristics of Differentially Expressed Genes in Cold-stressed Suppression Subtractive Hybridization Library of Winterfat

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As a high stress resistance psammophyte, winterfat, *Krascheninikovia lanata* (Pursh) A. Meeuse & Smit, has been successfully introduced into many countries. The leaves and branches of winterfat grown in room temperatures (15-25°C) and under cold stress (-10-5 °C) were used as the Driver and the Tester, respectively. Both Tester and Driver ds cDNA were prepared from their high quality mRNA, which were purified from their total RNA. Tester and Driver cDNA were separately digested to obtain shorter, blunt-ended molecules by RasI. Two Tester populations were created with different adaptors, while Driver cDNA had no adaptors. Differentially expressed genes were equalized and enriched by two round subtractive hybridizations using excess Driver population as compared with Tester population. The differentially expressed cDNAs were exponentially amplified by first round suppression PCR using the diluted hybridization product as template. The secondary PCR was performed using the first PCR product as template by nested primers to finally enrich the differentially expressed cDNAs, which consist of the SSH library of winterfat. These cDNAs were inserted into vectors and 362 cDNA clones were obtained. The sequencing results showed that some cDNAs of cold-stressed winterfat SSH library had relatively high homology with known stress resistance-related genes or proteins. Other cDNAs are new genes which are firstly reported. Our results lay a foundation

for the cDNA cloning of valuable genes, including antifreeze, heat-resistant, drought-tolerant and alkali-salt-tolerant genes, and their transgenic applications.

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### **(065) Isolation and Characterization of Salicylic Acid Induced Transcription Factor SIWRKY from Tomato**

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WRKY transcription factors belong to a large family of zinc finger regulatory proteins in higher plants in many biological processes, such as responses to biotic and abiotic stress, plant development and metabolism. However, cloning, expression and function of WRKY family of tomato are little studied. PCR primers were designed based on the conserved domain of *Solanum tuberosum* and *Capsicum annuum* WRKY transcription factor. The full-length cDNA of WRKY-like gene was cloned from the four-leaf stage tomato using homology-based cloning and RT-PCR methods four hours after inducing by 5mM salicylic acid. Various bioinformatics methods including blastn, ORF Finder, and DNAMAN were used to analyze and predict the feature and possible functions of the novel cDNA sequence. The result showed that SIWRKY is a full-length of the novel gene. Sequence analysis indicated that SIWRKY has one conserved WRKY domain and one zinc finger structure, consisted of 975 nucleotides, and deduced amino acid sequence containing 254 amino acids. For the putative protein, SIWRKY has 83% and 64% similarity with WRKY-like transcription factor of *Nicotiana tabacum* and *Vitis vinifera* respectively. The relative high similarity with WRKY transcription factors in other botanic species was found as well. Semi-quantitative RT-PCR demonstrated that the corresponding mRNA of SIWRKY was expressed at a similar level in root, stem and leaf of tomato, and accumulated abundantly 2-8h after treatment upon 5mM salicylic acid. The research indicated that the SIWRKY gene may function in plant development and plays a role in plant tolerance to biotic stress, and it has been found that members of plant WRKY transcription factor families are widely implicated in defense responses. So, due to the potential of biotic and abiotic stress activity, tomato SIWRKY gene can be used to enhance resistance against fungi. Therefore, the functions of the novel gene are valuable for further investigations.

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### **(066) Shoot Tip Cryopreservation of *Solanum tuberosum* Germplasm**

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Liquid nitrogen storage of vegetatively-propagated germplasm collections is the most economic and reliable long-term preservation method for many of these collections. Over the past 11 years, the USDA-ARS National Center for Genetic Resources Preservation (NCGRP) cryopreserved over 100 different potato (*S. tuberosum*) germplasm accessions originating from six different countries including the United States. In vitro shoot tips of these accessions are currently processed using the droplet vitrification method described by Haeng-Hoon et al. (2006). Our goal is to place 150 shoot tips per accession into long-term liquid nitrogen storage. In the first years of the program, the post cryo viability was relatively low with 25 to 40% of the cryopreserved shoot tips surviving and growing into plants. With improvements in methodology, shoot tip viability increased from 40 to 100% in some accessions. Genotype specific responses to cryo tolerance were observed. In addition to the liquid nitrogen storage, all potato accessions stored at NCGRP are also maintained in vitro as minitubers, undergoing a periodic shoot initiation and retuberization. The cryopreservation method used for potato germplasm accessions is very efficient; however, research on protocol modifications is still needed to accommodate cryo storage of recalcitrant potato genotypes.

*Specified Source(s) of Funding:* USDA-ARS CRIS

### **(067) Effect of Carpel Primordia-targeted Inhibition of Ethylene Perception on Sex Expression and Fruit Ripening in Melon (*Cucumis melo* L.)**

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Ethylene is a key factor modulating sex expression in cucurbits. Our previous studies indicated that ethylene perception by stamen primordia, but not carpel primordia, is essential for production of carpel bearing buds. Transgenic andromonoecious melon plants (male and bisexual flowers) expressing the dominant negative ethylene perception mutant gene, *etr1-1*, under control of the carpel- and nectary- directed *CRABSCLAW* (*CRC*) promoter showed increased and earlier carpel bearing buds and flowers. To further investigate this phenomenon, which could be potentially useful for earlier fruit production, we examined: ethylene production by *CRC::etr1-1* plants; asked whether increased femaleness also was observed in a monoecious (male and female) genetic background; and observed transgenic andromonoecious and monoecious *CRC::etr1-1* plants in the field for sex expression and fruit ripening. It has been frequently observed that lack of ethylene perception results in increased ethylene production due to lack of feedback inhibition. Floral buds from *CRC::etr1-1* plants showed elevated ethylene production, suggesting that increased femaleness may result from perception of increased ethylene by the stamen primordia. To test the effect in a monoecious background, gynoeious 'WI998' (W) melon was crossed with the andromonoecious 'Hale's Best Jumbo' (H) *CRC::etr1-1* and wild type (WT) plants. Greenhouse observations of the transgenic F<sub>1</sub> progeny showed increased femaleness relative to WT F<sub>1</sub> as evidenced by increased number of carpel bearing buds and open flowers and earlier onset of carpel bearing buds on the main stem. Field studies of the H-WT, H-*CRC::etr1-1* T<sub>2</sub> lines M5 and M15, (W x H)-WT F<sub>1</sub>, and W x H-*CRC::etr1-1* M15 F<sub>1</sub> lines also showed increased number of carpel bearing buds and open flowers, and earlier onset of the first open carpel-bearing flower. An additional phenotype observed in the greenhouse for H-*CRC::etr1-1* plants was frequent conversion of bisexual buds to female. The H-*CRC::etr1-1* T<sub>2</sub> M5 and M15 plants also showed about 60% conversion of bisexual to female flowers in the field. The *CRC::etr1-1* transgene also influenced fruit ripening in both andromonoecious and monoecious genotypes. The exocarp remained green while the mesocarp became extremely soft. This observation likely reflects differences in requirement for ethylene for different ripening processes. Thus, targeting inhibition of ethylene perception to the carpel and nectary led to increased and earlier carpel-bearing buds in the greenhouse and field, however, the transgenic plants exhibited an adverse phenotype of asynchronous ripening between the exocarp and mesocarp.

### **(068) Molecular and Cytogenetic Characterization of Watermelon using DNA Markers and FISH**

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We did fluorescent *in situ* hybridization (FISH) in cultivated watermelon var. *lanatus* (PI 270306) and its wild counterpart var. *citroides* (PI 244018), using 18S-28S rDNA and 5SrDNA probes. Well separated somatic chromosomes were prepared from root meristems, using enzyme digestion technique for *in situ* hybridization following the standard protoplast technique to prepare somatic chromosome spread. We have observed two different organizational features in these two species. In *lanatus*, we have identified two major 18S-28S rDNA sites and these are located on two different homologous pairs of chromosomes. One 5S rDNA site, on the other hand, was observed and located on a pair of homologous pairs of chromosomes. A two-color FISH (dual FISH) showed the 5S rDNA site was located interstitially and was syntenic to one of the 18S-28S rDNA sites. As revealed by the interphase FISH, the 18S-28S rDNA and the 5S rDNA loci are spaced out and may not tightly linked to each other. In contrary, only one 18S-28S rDNA site and two 5S rDNA sites were observed in *Citroides* accession (PI 244018). To our knowledge, it is unusual in plant species, where the number of 18S-28S rDNA sites is always higher than the 5S rDNA site. A dual FISH showed that all three rDNA sites were on three different pairs of homologous chromosomes. During the evolutionary process the 18S-28S rDNA site has been duplicated in *lanatus* and one of the 5S rDNA sites might have lost in this species. These results indicated that some structural rearrangements might have occurred during the evolution of *lanatus*. Further, meiotic analysis of pollen mother cell involving the rDNA FISH with 18S-28S rDNA and 5S rDNA probes would shed light on structural rearrangements in *lanatus*. The current research also explored additional insights such as extent of diversity at the methylation level among the watermelon cultivars. DNA profiles were generated using Methylation-Sensitive AFLP Assay for 47 watermelon heirlooms. Results indicated that methylation specific diversity (43%) in US watermelon heirlooms is higher than the diversity (19.8%) as estimated by several investigators using conventional DNA markers.

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### **(069) Influence of Hydrolytic Enzymes on Protoplast Isolation in *Carica Papaya L.* var. Maradol**

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Papaya (*Carica papaya* L.) is one of the most important fruit crops grown in Mexico, however, this crop is highly susceptible to *Papaya ringspot potyvirus* (PRSV-P). Somatic hybridization by means of the fusion of protoplasts from papaya and its well known PRSV-P-resistant relatives represents one of the most important efforts to reduce the PRSV-P incidence in this plant species, therefore, efficient protocols for isolation and purification of viable protoplasts from these species are necessary. The aim of this work was to evaluate several concentrations of mixtures of the hydrolytic enzymes cellulase, pectinase and driselase in order to assess their response in yield and viability of protoplasts isolated from somatic embryos of papaya variety Maradol. Papaya somatic embryos were placed in Petri dishes containing 10 mL of each of the solutions composed of the enzyme mixtures, and then incubated on a rotary shaker at 33 rpm, under darkness at 25°C for 16 h. After that, protoplasts contained in the obtained suspension were isolated and purified through filtration and centrifugation, followed by resuspension in sucrose. Viability of the protoplasts was assessed by staining them with methylene blue dye, and counting up was made using a hemacytometer under light microscopy. The mixture of hydrolytic enzymes composed of 1% cellulase + 0.2% pectinase + 0.2% driselase produced the highest protoplast yield ( $1.22 \times 10^6$  protoplasts per gram of fresh weight of somatic embryos). On the other hand, 34.24-60.76% were the two highest viability values obtained with all combinations with the three enzymes, except those with 3% cellulase, where the lowest viability values (0-9.95%) were obtained. Hydrolytic enzymes which have more influence in these two evaluated variables were cellulase from *Aspergillus niger* and driselase from *Basidiomycetes* spp., whereas the effect of pectinase from *Rhizopus* sp. was not significant.

*Specified Source(s) of Funding:* Universidad de Colima

Thursday, August 5, 2010 Springs F & G  
**Genetics/Germplasm/Plant Breeding: Fruit/Nut Crops 3**

**(030) Mapping of Quantitative Trait Loci (QTL) for Fruit Quality Traits in *Malus* Using Simple Sequence Repeats (SSRs)**

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A segregating mapping population of Coop 17 x Coop 16 cross was used to identify quantitative loci associated with various fruit quality traits. Using a total of 94 seedlings and the two parents, three apples per seedling were phenotyped over two years for several fruit quality traits. Phenotypic data were collected for fruit firmness, shape, weight, sugar content (°Brix), and titratable acidity (TA). Moreover, the mapping population along with the parents were subjected to genetic screening using 502 Simple Sequence Repeats (SSRs). These SSR markers were derived from bacterial artificial chromosome (BAC) end sequencing, expressed sequence tag (EST) sequences, and previously published markers. These were selected based on their ability to detect polymorphism in *Malus*, and were also previously used in a large *Malus* genetic mapping project. Depending on the trait of interest, significant differences were observed for years and genotype by environment interactions were also detected. Data analysis yielded 20 linkage groups on a fairly high-density linkage map. Three of the linkage groups mapped at opposite ends of chromosomes that comprise the 17 linkage groups and corresponding to the 17 chromosomes of the apple genome. Simple interval mapping (SIM) yielded a number of QTL for fruit quality traits, which were refined using composite interval mapping (CIM) involving marker cofactors.

*Specified Source(s) of Funding:* Illinois Plant Breeding Center - Pioneer Fellowship

**(031) Construction of a Genetic Linkage Map for Identification of Molecular Markers Associated with Resistance to *Xanthomonas arboricola* pv. *pruni* in Peach [*Prunus persica* (L.) Batsch]**

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Bacterial spot, caused by *Xanthomonas campestris* pv. *pruni*, is a serious disease that can affect peach fruit quality and production. The molecular basis of its tolerance and susceptibility is yet to be understood. To study the genetics of the peach in response to bacterial spot, an F<sub>2</sub> population of 188 individuals from a cross between Clayton, a resistant phenotype, and O'Henry, which is very susceptible to bacterial spot, was created. The 432 SSR markers already mapped in *Prunus* were tested for their poly-

morphism. Only 25% (108) were informative and were used in development of a genetic linkage map. The  $F_2$  population was planted at three locations: Sandhills Research Station, Jackson Springs, NC; Sandhill Research and Education Center, Pontiac, SC; and ARS-USDA Southeastern Fruit and Tree Nut Laboratory at Byron, GA. Field data for response to bacterial spot infection were collected three times a year from two locations, NC and SC. Preliminary data indicate involvement of one or two major genes in peach having resistance to bacterial spot leaf infection. The genetic map in combination with field data will be used to locate the region(s) in the genome associated with bacterial spot resistance. Marker-assisted selection for bacterial spot resistance will be discussed.

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### (032) Identification of *Castanea* spp. Cultivars using Burr and Nut Morphological Characteristics

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This study was conducted to develop effective methods for chestnut cultivar identification based on the burrs and nuts morphological characteristics using the major chestnut cultivars in Korea. A total of 23 morphological characteristics comprising 13 quantitative characteristics and 10 qualitative characteristics of 29 major cultivars of chestnut (*Castanea* spp.) growing in the Chestnut Gene Bank of Korea Forest Research Institute (KFRI) were investigated. Of the 23 quantitative and qualitative characteristics of burr and nut in fall only burr characteristics were useful for identifying varieties such as 'Tanzawa', 'Isseumo', 'Yamatowase' and 'Parkmi2'. New varieties released by KFRI such as 'Daehan', 'Mipung' and 'Jangwon' showed significant differences in nut characteristics in particular and all but 'Sandae' and 'Eunsan' of the 29 varieties (93.1%) could be effectively identified based on the nut characteristics. For identifying varieties the logic model using the discrete data was equivalently effective as the identification key based on the qualitative morphological characteristics. Of the discrimination model using the measurable data of nut and burr characteristics, Fisher's linear discriminant function rule which showed 18.1% of misidentification rate appeared to be most appropriate for the identification of varieties.

### (033) Genetic Diversity in Chestnut Germplasm Assessed by Nuclear and Chloroplast Simple Sequence Repeat Markers

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To assess the genetic diversity in chestnut germplasm (*Castanea* spp.), we used 15 nuclear simple sequence repeats markers (ncSSR markers) from *Castanea mollissima* (Inoue et al., 2009) and 10 chloroplast simple sequence repeats markers (cpSSR markers) from *C. sativa* (Sebastiani et al., 2003; Inoue et al., 2007). 80 genotypes from 9 chestnut species containing *C. sativa*, *C. mollissima*, *C. crenata*, *C. seguinii*, *C. henryi*, *C. dentata*, *C. alnifolia*, *C. ozarkensis* and *C. pumila* in chestnut germplasm were used in this research. Total DNA were isolated from the mature leaves of each genotype and used for SSR polymerase chain reaction (PCR) with ncSSR and cpSSR primers. The PCR products were separated using an ABI3130xl sequencer with the Genemapper software and a GS500LIZ ladder. Pairwise genetic distances were determined on the basis of the proportion of shared alleles for all the genotypes and the dendrogram were generated using the unweighted pair group method with arithmetic mean (UPGMA) cluster analysis method. By the 15 ncSSR primers, 22-129 putative alleles per locus were detected and 3-60 species specific alleles were identified. The 9 species used in this study were identified to different cluster by using the allelic information obtained from the 15 ncSSR loci. *C. crenata*, *C. seguinii*, and *C. dentata* were belonged to a single clade in a dendrogram. Another 6 *Castanea* species also belonged to another single clade. On the other hand, by the 10 cpSSR primers, 2-7 putative alleles per locus were detected. All the genotypes were classified into 16 kinds of haplo type by the genotypes of cpSSR loci. The 9 species used in this study were also identified to different haplo type by using the allelic information obtained from the 10 cpSSR loci. The 8 *Castanea* species without *C. crenata* were belonged to a single clade in a dendrogram. The difference in a result of classification between ncSSR and cpSSR genotypes is discussed in this presentation.

### (034) Analysis of Genetic Diversity in Pear Genotypes using Apple EST-SSRs

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A total of eight apple simple sequence repeat markers derived from expressed sequence tags (EST-SSRs) were used to assess the genetic diversity among 48 genotypes of pear (*Pyrus*). Primer pairs of all eight EST-SSRs gave amplification products when tested on all pear cultivars, and sizes of amplification bands were similar to those observed from apple. A total of 140 gene loci were identified, of which 129 (92.14%) were polymorphic, and different pear cultivars could be readily distinguished. Based on polymorphisms revealed by these markers, an Unweighted Pair Group Method with Arithmetic mean (UPGMA) cluster analysis was performed using soft NTY-SIS-pc2.01. Pear genotypes were classified into two major clades and grouped based on Asiatic and European origin of these genotypes with a stringency coefficient of 0.62. It is interesting to note that the following three species, *P. bretschneideri* Rehd., *P. ussuriensis* Maxim, and *P. pyrifolia* Nakai., originating from China, could not form an independent group.

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Springs F & G

## Postharvest 3

### (115) Fruit Detachment Force of Southern Highbush Blueberry: An Aid to Selection of Cultivars Suitable for Mechanical Harvest

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Blueberry (*Vaccinium* spp.) acreage has expanded significantly in the last decade in the southeastern region of the U.S. and the value of Florida's fresh-market blueberry industry has steadily increased to \$73 million in 2009, up 87% from the 2007 season. Many new plantings are being established and this trend will likely continue for the near future. A number of factors have contributed to this trend; among them are the availability of commercial southern highbush cultivars from the Univ of Florida (UF) breeding program and the availability of dormancy-breaking chemicals. With these, growers from southern Georgia to southern Florida can harvest in the high-value market window of mid-April to mid-May. Currently, fresh-market blueberries are hand harvested in Florida at an estimated cost of \$1.54/kg. However, mechanically harvested blueberries could lower harvest costs to <\$0.22/kg, reducing harvest costs statewide by >\$4 million. Blueberries mature at different times on the same

plant, necessitating multiple harvests, and one factor affecting the adoption of mechanical harvest is fruit detachment force (FDF). Ideally, blueberries that are immature (green stage) or unripe (red stage) would have a higher FDF than those that are ripe (blue stage), enabling selective, multiple harvests. In May 2009 FDF was determined on full-sized green, red and blue fruit considered as having potential for mechanical harvest: three commercial cultivars ('Sweetcrisp', 'Star', and 'Farthing') and seven UF breeding lines (01-173, 06-465, 06-556, 06-553, 06-571, 06-80, 06-83). Individual fruit were detached (15 to 20/ color stage) using a handheld, digital force gauge fitted with a dual wire, curved probe. For each reading, the stem adjacent to the pedicel was secured with one hand and the probe was inserted on either side of the fruit pedicel to contact the stem-end of the fruit. The gauge was then pulled out with uniform motion and maximum FDF was recorded upon fruit detachment. Green fruit required more FDF (1.8 to 3.5 N) than blue fruit (0.7 to 1.5 N) for all but 'Sweetcrisp'. FDF for red fruit from lines 06-465 and 06-80 was lower than green fruit, but only the former was higher than blue fruit. These results indicate that green fruit from most of these cultivars/lines would not be removed from the bush with a properly adjusted mechanical harvester and that breeding line 06-465 shows potential for selective harvest of blue fruit.

*Specified Source(s) of Funding:* Self

### (116) Extending the Use of Ultraviolet Light for Fruit Quality Sorting in Citrus Packinghouses

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Illumination with ultraviolet light (UV) is commonly used in citrus packinghouses as a means to aid in the identification and removal of decayed oranges from the packline. This technique is effective because areas of decay strongly fluoresce under UV illumination. It was observed that oranges often have other areas on the peel with lesser degrees of fluorescence and experiments were conducted to determine if their abundance was predictive of fruit quality after storage. Three separate experiments were conducted using the UV room of a packinghouse where oranges were removed from the packingline and placed into different classes based upon the amount of peel fluorescence present: class 0, having little or no fluorescence; class 1, having a limited number of small fluorescing areas; class 2, having numerous fluorescing areas; and class 3, having large fluorescing areas indicative of decay or severe mechanical injury. The following day and again after 3 weeks at 15 °C the fruit were evaluated and separated into groups based upon peel quality and the presence of decay. Marketable fruit were considered

to be fruit that could be classified as either fancy or choice grade. Class 3, which would be the fruit removed in the UV rooms under current practices, had high levels of decay and only 5% of the fruit could be considered as marketable after 3 weeks of storage. Classes 0 and 1, representing fruit with no or low amounts of fluorescence, were similar in quality and had an average of 57% of the fruit being marketable after 3 weeks of storage. Only 28% of fruit in class 2, however, were marketable after the same amount of storage, this being due to lesions on the peel and decay that occurred during storage. Peel UV fluorescence, even at amounts below what are currently considered in commercial packinghouses, appears to be predictive of orange quality following storage.

### **(117) Citric Acid Reduces Browning of Fresh-cut Potato by Means other than as an Acidulant**

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Enzymatic discoloration in fresh-cut potato during handling develops due to polyphenoloxidase (PPO) activity. The optimum PPO activity pH is 5.25–5.75, with limited activity below 4 and above 7. Therefore; in order to study the solution pH effect on browning, potato slices were dipped in organic (citric acid; CA) and inorganic (HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub> or NaOH) solutions at various pH levels (2.24–11.58) and browning on slices was evaluated after 6 days storage at 5 °C. The most severe browning occurred after dipping in pH 5.7–5.8 solutions as indicated by 12–14%  $\Delta L^*$  and 9–10  $\Delta E$ , where  $\Delta E = (\Delta L^*2 + \Delta a^*2 + \Delta b^*2)^{1/2}$ . Browning was reduced in proportion to the concentration of CA from 0.5 to 2%, even when the pH was held constant at the lowest level (2.24). Color changes of potato slices previously dipped in alkaline solutions of pH 7.9–11.6, remained at the same high levels as the control (10.3–12.5%  $\Delta L^*$  and 8–9  $\Delta E$ ), indicating that there was no inhibitory effect of the high pH solutions on browning development. In contrast, a pH 2.3 HNO<sub>3</sub> solution (0.0353%) significantly reduced % $\Delta L^*$  and  $\Delta E$ , similarly to 2% CA, whereas HNO<sub>3</sub> solutions of pH 3 or 4 proved insufficient to control browning. Dipping potato slices in pH 2.4–4 H<sub>2</sub>SO<sub>4</sub> solutions (0.04021–0.00098%) also reduced browning, although not as well as 2% CA or pH 2.3 HNO<sub>3</sub> solutions. Visual evaluation based on the per cent slice discolored area revealed that dipping in a  $\geq 1\%$  CA solution resulted in the lowest discoloration score (DS=2.6–3.2 out of 6), not significantly different from dipping in a pH 2.3 HNO<sub>3</sub> solution (DS=3.4), but lower than all the other treatments (DS=3.6–4.3). From the above, it appears that browning inhibition by CA is due to a mechanism other than acidification – possibly its ability to act as a copper chelating agent in the active site of PPO. It is possible that HNO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> similarly reduce browning by chelating copper rather than by reducing the solution pH.

### **(118) Insights Regarding Sensory Evaluation of Bitterness Development in Citrus Juice**

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Delayed bitterness is a well-known phenomenon in citrus juice and has a negative impact on juice quality. Bitterness results when the tasteless limonoic acid A-ring lactone (LARL) in juice is converted to the bitter compound limonin after juicing. Citrus varieties that produce juice that becomes bitter have limited utility for processing. USDA 1-105-106 is a promising new mandarin hybrid that produces juice with outstanding initial quality; however, the development of bitterness in this hybrid had not yet been quantified. The objective of this study was to quantify the kinetics of delayed bitterness in USDA 1-105-106, ‘Ambersweet’ (a sibling of USDA 1-105-106), and ‘Navel’, a sweet orange prone to development of bitterness. Fruits were harvested at weekly intervals from November to December of 2009, except ‘Navel’ which was only harvested in December, and juiced. Juice was divided into 4 one-L bottles and served to a trained panel within one hour of juicing, or after 4 and 24 hours at 10 °C. One additional bottle was stored at -20 °C and served after 4 weeks. Aliquots of juice from each harvest and sampling time were taken and subsequently analyzed for titratable acidity (TA), soluble solids (SS), sugars, acids, limonoids (limonin, nomilin and their glucosides) and volatiles. Ten trained panelists rated the juice for sweetness, sourness and bitterness on a 0-10 scale. Half of the panelists could discern bitterness in USDA 1-105-106 in samples stored for 24 hours as well as those that were frozen, but bitterness was not detected in ‘Ambersweet’. Variation in bitterness sensitivity is well-described and was observed in this specific group of tasters. Nevertheless, frozen stored ‘Navel’ juice was rated high in bitterness by all panelists. ‘Ambersweet’ tended to be perceived as more sour, which correlated with higher TA and lower pH. USDA 1-105-106 had generally higher nomilin levels, regardless of sampling time. There were no sensory character differences due to harvest date, although the first harvest had the lowest pH and TA in USDA 1-105-106, and highest levels of nomilin and limonin in ‘Ambersweet’. This study clearly showed sensory differences between sampling times for USDA 1-105-106 and ‘Navel’ juices but not for ‘Ambersweet’. Our results indicate that sensory evaluation should be performed at least after 24 hours of juicing, and/or

after freezing to effectively detect potential problems due to delayed bitterness.

### **(119) Postharvest Comparison of Raspberry Cultivars and Selections Grown under Tunnels or Field Systems in the North Carolina Piedmont**

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Raspberry production in the southeastern U.S. has been a challenge for many years, as the high humidity and high temperatures tend to reduce fruit size, accelerate ripening, and exacerbate Botrytis cinerea. There is considerable interest in North Carolina to grow local raspberries as a specialty crop. Raspberry plants from multiple breeding programs were grown in field and tunnel systems in Salisbury, NC representing the Piedmont area of NC and treated conventionally with a recommended fertilizer and fungicide regime. Air temperatures during the florican season (May-July) are 23-32 and 13-19 C (max/min), and 28-17 and 16-4 (max/min) in the primocane season (August-November). Humidity is 70 to 95% during the production season. Fruit were harvested when detachable from the receptacle into 160 g clamshell boxes and held at 5 C, 95% RH for 4-6 days, until mold was visible on berries. Color was determined subjectively on a 1 (light red) to 3 (too dark) scale. Fruit were determined to be soft or firm when taken individually out of the clamshell, and 10 soft and 10 firm were also tested using a firm tester with fruit set calyx end down. Most of the cultivars tested were rated as too dark (3) after storage for 4-6 days at 5 C. For most of the stored fruit, more than 50% were considered soft after removal. Firm and soft fruit measured 2 and 0.5 N, respectively. Of the selections and cultivars tested, NC344 and Nantahala, both developed under local conditions, had lighter red and firmer berries. Tunnel berries were slightly better in postharvest quality than the field grown fruit.

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### **(120) Laser Labeling of Valencia Oranges Does Not Facilitate Growth or Penetration of Salmonella Present on the Peel Surface**

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In laser labeling of fruits and vegetables the desired information is etched onto the produce surface using a low-energy carbon dioxide laser beam (10,600 nm). Etched characters are formed by surface depressions in the epidermis that seemingly facilitate entrance of decay and pathogenic organisms. The objective of this study was to determine the effect of laser labeling and different post harvest treatments on *Salmonella's*, ability to survive/grow and penetrate into the fruit. A five strain cocktail *Salmonella* was spot inoculated onto Valencia orange peels in different sequences with wax application and laser etching. Inoculated samples were stored at 10 or 26, and a combination of 10 and 26°C for up to 42 days. Etched peels and corresponding juices were extracted and enumerated for *Salmonella*. No set of conditions promoted the growth of *Salmonella* on the fruit surface, or allowed penetration into the juice. Survival of *Salmonella* populations on the peel surface did not differ between any of the treatment and control, unlabeled samples. In all cases, *Salmonella* declined between 1.5 and 3.0 log CFU/orange after 30 days, with faster declines noted at 10°C. Based on the data obtained from the many combinations of treatments and under conditions extremely unfavorable and unrealistic in terms of fruit storage, laser labeling citrus fruit peels and subsequent waxing in any order does not allow for the growth nor influence the natural decline of *Salmonella* populations on citrus fruit surfaces as compared to controls.

### **(121) Comparison of Oxidative Enzymes and Redox Active Compounds Between Fresh Squeezed and Processed Orange Juices**

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Commercially processed (CP) orange juice (OJ) and fresh squeezed juice with or without pasteurization (F and F+P, respectively) at 90 °C for 10 s, were compared for antioxidant compounds and activities of antioxidant-related enzymes in juice

of Valencia oranges. Samples were examined at 0, 1, 2 and 4 days of 5 °C storage after juicing. Samples were extracted with a Tris buffer with protease inhibitors for measuring enzyme activities and with 6% trichloroacetic acid for redox active compounds. Total phenolic content (TPC) samples were extracted by boiling with 50% ethanol. All extractions were rapidly frozen in liquid nitrogen before storage at -80 °C. Enzyme activities measured were catalase (CAT), ascorbate peroxidase (APX), peroxidase (POD), superoxide dismutase (SOD), monodehydroascorbate reductase (MDHAR), dehydroascorbate reductase (DHAR) and glutathione reductase (GR). Redox active compounds (RACs) measured were ascorbate (AsA), dehydroascorbate (DHA), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), glutathione (GSH) and oxidized glutathione (GSSG). For a given enzyme, treatment effects gave converging activity levels over 4 days for CAT and DHAR, their activities were observed to be high in F and F+P juice extracts while APX activity was high in F+P, and MDHAR, SOD and GR activities were high in CP. Enzyme activities found to converge to a common level across 4 days of storage in F, F+P and CP juices were DHAR, GR and SOD. Enzyme activities diverging to different levels by treatment were POD and CAT (both with F high, CP low at 4 days). For RACs, only H<sub>2</sub>O<sub>2</sub> was consistently high in F, and only DHA was consistently high in CP. DHA was the only RAC to converge for all three treatments across 4 days, and AsA was the only RAC to diverge (F, F+P high, CP low). Relative to F and F+P juices, commercially processed juice had lower MDA levels, lower total antioxidant capacity, and lower antioxidant reductive capacity. TPC measured by modified Folin-Ciocalteu showed commercial juice had higher TPC, consistent with HPLC-MS analysis of major phenolics in these juices. Headspace analysis for aroma volatiles showed terpenoid compounds higher in processed juice and esters higher in fresh juice. But, our fresh squeezed OJ had >8X higher levels of peel oil than processed juice, which may explain some of the observations above. Fines of solid orange constituents suspended in commercial OJ would not typically be seen in fresh squeezed product but may also influence the levels some of the above measures.

### **(122) Increasing Consumption of Specialty Crops by Enhancing Their Quality and Safety**

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Despite widely advertised health benefits, most Americans do not eat their recommended daily servings of fruits and vegetables.

We believe that inconsistent produce quality, particularly flavor, is a key factor contributing to this low consumption. Poor tasting produce is often associated with varieties that lack good flavor potential, immature products, and/or products that have been transported and stored in less than optimal conditions. This Coordinated Agricultural Project aims to help producers remove postharvest impediments that are keeping consistently great tasting produce from being marketed. Our goal is to show how fresh fruits and vegetables with enhanced flavor can be successfully handled, without compromising food safety, so as to improve consumer satisfaction and thereby change their buying habits to increase consumption. With a view toward increasing consumption of fresh fruits and vegetables, we are developing harvest and postharvest handling strategies that improve flavor quality and safety for consumers. Our project brings together scientists from the Univ of California, Univ of Florida, and the USDA in partnership with leading growers, shippers, and retailers of berries, melons, pears, stone fruits, and tomatoes. Initially, we are identifying the critical flavor descriptors for each of these products and determining how produce flavor, as affected by harvest and postharvest practices, influences consumer purchasing decisions. We are also developing and evaluating rapid methods to monitor harvest maturity and critical eating quality characteristics identified by consumers. We will then develop and test improved supply chain capabilities to deliver produce with enhanced eating quality. Potential food safety risks associated with handling more mature or riper produce will also be determined. Our findings will be integrated into commercial operations and used to educate all participants in the postharvest value chain, including consumers, about optimal produce maturity, ripeness, quality and handling practices. We will regularly review project impacts on handling practices and purchasing behavior and determine the return on investment of new technologies and practices in terms of increased produce sales prior to recommending them to industry. We believe our research will provide the produce industry with practical strategies for consistently supplying riper, more flavorful fruits and vegetables to consumers.

*Specified Source(s) of Funding:* USDA-CSREES Specialty Crops Research Initiative

Thursday, August 5, 2010

Springs F & G

## Vegetable Crops Management 2

### (280) Transplant Age and Variety Affects Performance of Transplanted Sweet Corn

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Although the overwhelming majority of sweet corn produced in the United States is direct seeded and grown on bare ground, a small portion of farmers are to transplanting sweet corn on plastic mulch. Primary reasons why growers are transplanting sweet corn include, capitalizing on high early season prices in local retail markets, less insect pressure early in the season reducing the need to employ insecticidal sprays, and enhanced germination of some sweet corn varieties in transplant cells. However, empirical data suggests that transplant age and days to maturity can significantly affect quality and yields of transplanted corn. To determine how transplant age and days to maturity can affect yield and quality of sweet corn, six varieties: 'Frisky,' 'Temptation,' 'Synergy,' 'Montauk,' 'Providence' and 'Cameo,' of bi-color sugar enhanced sweet corn with maturity times ranging from 65 to 84 days were grown. Transplants were grown for 13, 15, 17, 20, 22 and 24 days from seeding. A direct seeded treatment was evaluated as well. This study was performed at two locations: Lexington, KY and Quicksand, KY in the spring of 2009. Treatments were arranged in a completely randomized seven by six factorial design with four replications. Plants were seeded into 128 cell trays, with two seeds per tray for each transplant time. At planting, cells containing two plants were transplanted into raised beds of black plastic mulch. Each bed contained two rows of corn with 0.5 m between row and 0.3 m within row spacing. Beds were formed on 1.8 m centers. This resulted in a population of 71,730 plants·ha<sup>-1</sup>. Each treatment plot contained 40 plants. There was a significant variety (days to maturity) by transplant age interaction for yield, ear width and length, stand count (survival), ear height and tassel height. Yields ranged from zero marketable ears for 'Frisky' transplanted at 24 days after seeding to 5545 dozen ears·ha<sup>-1</sup> for 'Temptation' transplanted at 13 days after seeding. Measurements for ear length and width were generally lowest in the earliest maturing varieties that were the oldest when transplanted. The results of this study suggest that transplanting sweet corn is affected by both transplant time and variety and that choosing the wrong combination can be detrimental to productivity.

*Specified Source(s) of Funding:* Kentucky Horticulture Council

### (281) Killed Cover Crop Residue Impacts on Onion Growth and Management in Semi-arid New Mexico

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Alternative cultural practices in vegetable farming are one way in which the arid southwest is adjusting to its limited water resources and urban expansion. During the summer months in the U.S., New Mexico is a major supplier of fresh market onion (*Allium cepa*), producing nearly 80% of the crop, and accounting for about \$47.5 million in sales in 2008. The use of killed cover

crops as a pre-plant practice may be one way to moderate water use, improve stand establishment, and increase yields of direct seeded, spring-sown onions. The presence of cover crops can also decrease feeding of onion thrips (*Thrips tabaci*) and their associated damage including the spread of pathogens, particularly the economically important *Iris yellow spot virus* (IYSV). In this study, four annual cover crop species were evaluated for their impact on soil moisture content of spring-sown onion in the field. Field research was conducted at the New Mexico State Univ Leyendecker Plant Science Research Center. Cover species included oats (*Avena sativa* 'Monida'), ryegrass (*Lolium multiflorum* 'Gulf'), winter rye (*Secale cereale*) and winter wheat (*Triticum aestivum* 'Promontory'). Cover crops were established in the fall, overwintered, then killed with the application of glyphosate, and plant biomass was left undisturbed. An in-furrow application of wheat straw was used as a fifth cover treatment in addition to a bare soil control. Plots were established in a randomized complete block design (RCBD) with four replications and irrigation was accomplished by flooding furrows. Spring onion cultivar 'Caballero' was direct seeded in March 2009, and irrigation scheduling was established using soil moisture equipment utilizing Frequency Domain Reflectometry (Diviner 2000). IYSV disease severity was measured using a scale of 1-9 to evaluate disease pressure in each treatment. Soil moisture content data indicates that the cover treatments provided a buffer from water loss in the top 40 cm of the soil in this water intensive crop while also decreasing IYSV disease pressure. However, the presence of the cover crop residues presented some cultural challenges including an allelopathic effect in the ryegrass treatments. Consequently, photosynthesis rates and yields were depressed in these treatments. A killed cover crop can provide both the benefit of a cover for input reduction, and also contributes to a diverse rotation schedule, but must be managed with the primary crop with care.

*Specified Source(s) of Funding:* Rio Grande Basin Initiative administered through USDA-NIFA.

### **(282) Salinity and Type of Soil Affected Seedling Emergence and Growth of Four Peppers**

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High soil salinity often results in poor stands, reduces plant growth and yield in peppers. This study was to determine the effect of salinity of irrigation water and soil type on seedling emergence and growth of four peppers (*Capsicum annuum*) 'NuMex Joe E. Parker', 'NuMex Nematador', 'NuMex Primavera', and 'Jupiter'. In Expt. 1 and Expt. 2, seeds of the above peppers were

sown in loamy sand and silt loam soils and irrigated with saline solutions at electrical conductivity (EC) of 0.9 (tap water), 3.0, or 6.0 dS·m<sup>-1</sup> (Expt. 1) or at 0.0 (reverse osmosis, RO water), 0.9, or 1.5 dS·m<sup>-1</sup>. No seedlings were emerged when irrigated with solution at 3.0 and 6.0 dS·m<sup>-1</sup>. The salinity at the top soil layer increased linearly with time when tap and saline solutions were used in both soil types, while no substantial increase was found with RO water. Salt accumulation at the top soil layer was greater in loamy sand than in silt loam. Seedling emergence rate irrigated with RO water ranged from 70% to 80% in loamy sand and 60% to 70% in silt loam for all cultivars. With tap water and saline solutions, the emergence rate, varied largely with cultivar and soil type, ranged from 0 to 60%. 'NuMex Joe E. Parker' and 'NuMex Nematador' had higher emergence rates than the other two cultivars. In Expt. 3, seedlings were germinated in potting mix and grown in 1.8-L containers. Saline solution treatments of 1.4, 2.1, 2.9, 3.5, or 4.2 dS·m<sup>-1</sup> were initiated when seedlings reached 11 to 13 leaves stages. The reduction in shoot dry weight by the five-week saline solution treatments was greater in 'Jupiter' and 'NuMex Primavera' compared to 'NuMex Joe E. Parker' and 'NuMex Nematador'.

*Specified Source(s) of Funding:* RGBI, USDA CSREES

### **(283) Colored Plastic Mulches Influence Fruit Yield and Insect Population of Tomato and Pepper**

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Experiments were conducted in 2008 and 2009 to determine the influence of colored plastic mulches on fruit yield, insect population and the incidence of tomato spotted wilt virus (TSWV) in tomato and pepper. Mulched treatments were white on black, red, violet and aluminum coated arranged in a randomized complete block design and 4 replications. Fertilizer N, P, and K were applied at the rate of 134, 73, and 130 kg/ha, and 100, 73, and 120 kg/ha, for tomato and pepper, respectively, based on soil test. Plants of both species were transplanted to plots through holes in the mulch at an off set to reduced contact with fertilizer applied prior to planting based on soil test. Highest fruit yield for tomatoes was obtained from among plants mulched with white on black mulch while fruit yield of pepper was best among plants mulched with aluminum coated films. The number of insects collected from sticky traps was lowest for aluminum coated mulch, followed by the white on black mulch. The most common families of insects regardless of mulch color were Diptera>Hymenoptera>Homoptera. Both red and violet mulches had greater number of insects, suggesting that the incidence of TSWV would be greater when these mulches are used, and in fact, fruits of both species grown on violet showed marginal symptoms of TSWV.

*Specified Source(s) of Funding:* USDA/CSREES Evans-Allen



### **(284) Determining Redundancy of Current and Collected 'White Grano' Onion Accessions**

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The U.S. National Plant Germplasm System has a mission to efficiently maintain a collection of germplasm that is representative and genetically diverse. Reducing genetically-duplicate accessions and adding new and different germplasm to the collection will maximize genetic diversity in the collection. This study was conducted to determine redundancies in the current 'White Grano' onion (*Allium cepa* L.) germplasm in the U.S. collection. Some accessions appeared to be duplicates as indicated by their similar cultivar names. Another objective of this study was to evaluate recently-collected 'White Grano' germplasm to determine if there are duplications among them, and between them and the current 'White Grano' accessions in the collection. Eight similarly-named 'White Grano' accessions and collected cultivars were seeded in Oct. 2007 and in Sept. 2008. This group of cultivars consisted of four accessions that were already a part of the germplasm collection, and four newly-collected 'White Grano' cultivars proposed to be added to the collection. Plants from each accession were measured for 18 different morphological characters once the plants from the entries neared maturity. Characters measured included bolting percentage, sheath length and diameter, plant and leaf height, leaf width and thickness, and time when 20% of plants in the plot had reached tops down (20% tops down), 50% tops down, and 80% tops down. At the time of 80% tops down, the bulbs were harvested and the harvest date, pink root disease severity, and bulb number, height and diameter were measured. Two weeks after harvest, average bulb weight, bulb firmness, and the percentage of bulbs with a single growing point were measured. Two 'White Grano' accessions in the current collection may be removed, as they were determined to be duplicates of other accessions. One newly-collected 'White Grano' cultivar was found to be different from the accessions already in the collection and may add diversity to the collection. The characters among this group, that were most discriminating, were average bulb weight, percent single centers, bulb height and diameter, shape index, and leaf width and thickness. Characters, that did not discriminate among these accessions, were sheath length and diameter, uniformity of maturity, and plant and leaf height.

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### **(285) Effect of Growth Regulator (BENEFIT PZ) on Onion Productivity and Bulb Quality**

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Onion production in Mexico is about 45,000 ha annually. In Northern Sonora, Mexico the onion is important crop. Yield and quality is variable according to the technological capacity and economic status of the farmer. However, the technology adoption is increased during the last years for this reason, the yields and quality has been increased in the most crops. The objective of this experiment was to evaluate the effect of growth regulator BENEFIT PZ on productivity and quality in onion. Three treatments were evaluated: One foliage application of 1.5 L·ha<sup>-1</sup>, two foliage applications of 0.75 L·ha<sup>-1</sup>, and control (without application). This study was carried out in agricultural region of Magdalena de Kino, Sonora Mexico during autumn-winter 2007–08. The sowing date was 2 Oct. 2007 and trasplanting was 22 Dec. 2007. We used Stratus variety (white) and plant density of 370,000 plant/ha in furrows with four rows using drip irrigation systems. The harvest was 20 May 2008. The results show did not differences among treatments, the better yield were obtained with the treatment of two applications of 0.75 L·ha<sup>-1</sup> of BENEFIT PZ with 89.0 t·ha<sup>-1</sup> and bulb weight of 256 g. The lower yield was obtained the treatments of one application of 1.5 L·ha<sup>-1</sup> of BENEFIT PZ. With a yield of 83.3 t·ha<sup>-1</sup> and bulb weight of 254 g and finally the control treatment obtained a yield of 85.0 t·ha<sup>-1</sup> and bulb weight of 244 g.

*Specified Source(s) of Funding:* INIFAP-PRODUCE

### **(286) Evaluation of Two New Asparagus Varieties at the Agricultural Area of Caborca, Sonora**

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At this time, there are around 6500 has of asparagus established in the Caborca, Sonora region, being the main producing zone of green asparagus of México country. Besides the importance that represents this crops at national level, has a great socio-

economic impact by the economic utilities that it generates and by the amount of manual labor that it requires specially during the harvest period. The 100% of the production of this region is oriented to the export market. The objective of this research was the evaluation of two new varieties of green asparagus under the conditions of the agricultural area of Caborca, Sonora to diversify and to extend the harvest period. The evaluated varieties were Jaleo and Early Californian and those was compared with Brook as the regional control. Our results indicate that the two new varieties was precocious that the control variety, since its bud break of news, was greater at the beginning. With respect to yield, Jaleo variety was the most productive with 231 boxes, 28% over the regional control

*Specified Source(s) of Funding:* INIFAP-PRODUCE

## Thursday, August 5, 2010 Springs F & G Viticulture/Small Fruits 2

### **(256) Managing Cover Crops to Control Weeds, Conserve Soil Moisture, and Enhance Growth of Establishing Vines in Oregon's Willamette Valley**

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Cover crop biomass management is being evaluated in a 3-year trial to determine impacts on vine nutrition, water conservation, and reduced herbicide and fertilizer inputs in new vineyards. A winter annual cover crop of crimson clover and cereal rye was planted in a newly established commercial vineyard (2008). Cover was mown in spring and biomass distributed in four treatments compared to a non-cover treatment. In-row treatments of 0, 1x and 3x biomass mulch rates were compared to biomass incorporations into the alleyway and a non-cover cropped treatment. Each treatment was replicated five times with 20 vines per replicate. In season one (2009), leaf area per vine tended to be higher in mulched treatments than non-mulched, with no differences observed in shoot lengths. SPAD readings indicating leaf chlorophyll content were higher in mulched treatments than non-mulched treatments by mid-season. Leaf blade and petiole %C, %N, and C:N ratio at véraison were not different between treatments, though a trend was noted in leaf blade %N. Leaf blade and petiole macro- and micronutrient analyses by ICP will be performed in Mar. 2010. Soil nitrate and ammonia analyses will be performed in Feb. 2010. Vines were not water stressed throughout the season. Leaf and shoot biomass in destructively harvested grapevines was four-fold greater in the 3x mulch treatment. Fine root biomass of commercial vines was significantly

higher in the 3x mulch treatment. Volumetric soil moisture at 0–23 cm was greater in mulched than non-mulched treatments. In-row soil compaction was lowest in mulched treatments. In-row weed suppression was highest in mulched treatments with nearly 100% suppression of broadleaf and grass species. Preliminary data indicate that winter annual cover crops may not compete with young vines and may be managed to enhance growth in non-irrigated vineyards.

*Specified Source(s) of Funding:* Agricultural Research Foundation, and the Northwest Center for Small Fruits Research

### **(257) Plant Water Potential of Southern Highbush Blueberries (*Vaccinium corymbosum* hybrid) Grown in Different Pine Bark Amended Soils**

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Southern highbush (SHB) blueberries (*Vaccinium corymbosum* hybrid) require acidic soils that are well-drained and have high organic matter content. However, very few soils in Florida are suited for blueberry production without significant modification; as a result, blueberries are commonly planted on pine bark beds that are 15 to 18 cm high and about 1 m wide. This system may use up to 1000 to 1200 m<sup>3</sup>·h<sup>-1</sup> of pine bark at a cost that can exceed \$9500/ha. Physical and chemical characteristics of pine bark vary with age and level of decomposition. Commercial production systems using pine bark beds typically require more frequent irrigation than systems where plants are established directly in soil. Water management on pine bark beds is further complicated because blueberry roots are typically confined to the pine bark layer. The objective of this study was to evaluate drought susceptibility of SHB on several soil management systems during a dry period without irrigation. Predawn and solar noon plant water potential of 'Emerald' SHB was measured with a pressure chamber during a 25-day period in which no irrigation was applied. Four soil management systems were evaluated: 1) non-amended soil (NAS); 2) 8 cm of pine bark incorporated into the top 15 cm of soil (8 PBI); 3) 8 cm of pine bark incorporated into the top 15 cm of soil plus 8 cm of pine bark mulch (8 PBI+8M); and 4) 15 cm pine bark layer on top of non-amended soil (15 PBL). During the last week of the experiment differences were observed among treatments. The non-amended soil showed higher predawn plant water potential than '8 PBI+8M' and '15 PBL'. No differences were found at predawn between 'NAS' and '8 PBI'. No differences among treatments were observed in plant water potential at solar noon. The results suggest that SHB on highly amended soils may be more susceptible to prolonged droughts than SHB on non-amended soils.

### **(258) Delaying Budbreak in 'Edelweiss' Grapevines to Avoid Spring Frost Damage by Using NAA and Vegetable Oil**

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Delaying budbreak is an approach to avoid spring frost damage. A field experiment was conducted during the winter of 2009 at James Arthur Vineyards, Raymond, NE to study the effect of spraying NAA and vegetable oil (Amigo Oil, Loveland Industries, Greeley, CO) on delaying bud break in 'Edelweiss' grapevines to avoid such damage. The experiment consisted of five treatments: NAA (500, 750, and 1000 mg/l), oil applied at 10% v/v which consisted of 9.3% oil and 0.7% emulsifier, and the control which was not sprayed. There were four application dates: 6 Jan., 3 Feb., 3 Mar., and 1 Apr. 2009. Randomized complete block design was used with three blocks of 20 vines each. Each vine was sprayed with about 0.33 L. Two canes on each vine were randomly selected and budbreak was evaluated throughout spring until each cane reached 60% budbreak. During harvest, the number of clusters/cane and weight of clusters/vine were recorded. Berry samples were analyzed for pH, °Brix, and titratable acidity (TA). An additional experiment was conducted using forcing solution (Read et al., 1984) on 'Edelweiss' canes collected on the same dates of the field experiment. For each date, 20 canes were headed back to the first five buds, then cut into five single-bud cuttings and the bases immersed in forcing solution. The same previous treatments were applied by adding on drop on each bud. Days to budbreak and shoot length one week after budbreak were recorded throughout the study. Buds that didn't show budbreak were longitudinally sectioned and examined under a stereomicroscope to determine bud viability and any treatment phytotoxicity. Oil and NAA at 1000 mg/L significantly delayed bud break 2-6 days compared to the control. Treatment and month interactions were only found for bud break delay and pH. Treatments had no significant effects on yield, cluster weight, °Brix, and TA. The forcing solution experiment showed a month, position, and treatment interaction regarding bud break delay. No interaction was found regarding shoot length effect. Oil caused phytotoxicity on 10% of the buds examined, while NAA at 1000 mg/L delayed budbreak at the fifth bud position. Both experiments show that NAA at 1000 mg/l has the potential of delaying bud break in 'Edelweiss' grapevines without affecting the quantity or quality of production. It is proposed that grape growers may use NAA to delay bud break and possibly avoid spring frost damage.

### **(259) Cultural Practices to Improve Primary Bud Cold Hardiness of Vidal Blanc Grapevines in the Continental Climate**

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Grapes grown in Kentucky face challenges including bud injury due to frequent occurrence of late spring frosts and critical minima and fluctuating winter temperatures. Previously we demonstrated that yield components and cold hardiness were influenced by the severity of pruning and cluster thinning and cluster thinning alone defined the differences in leaf area: fruit ratio, vine size, and vigor. The current study investigates the effects of delayed pruning, cluster number and bud position on primary bud survival of field-grown Vidal blanc grapevines at three commercial vineyards in central Kentucky. Treatments were established in a randomized complete block design and all treatment vines were pruned to 20 +10 and shoot thinned to 3-5 shoots /m of row. Vines were subjected to delayed and early season pruning and either one cluster per shoot or no cluster thinning. Delayed pruning and increased crop level resulted in a decrease in primary bud cold hardiness and overall fruit quality compared to early season pruning. Primary bud survival was dependent on bud position where positions 1-4 were 60% more tolerant to freezing temperatures than bud positions 5-8. This data corroborates with our previous data suggesting that cluster thinning is the key component to maintaining vine sustainability of Vidal blanc with implications that bud position may impact primary bud hardiness.

*Specified Source(s) of Funding:* Kentucky Grape and Wine Council

### **(260) Reducing Grape Inflorescence Length to Decrease Cluster Compactness**

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Wine grape cluster compactness varies among varieties from loose to tight clusters, and can have implications in disease management. Grape varieties with loose cluster architecture

may allow for additional air circulation throughout the cluster, reducing disease incidence. European studies have indicated that cutting the apical portion of inflorescences can reduce overall cluster compactness. A two-year study was conducted in Prosser, WA to investigate the potential of inflorescence length reduction to decrease cluster compactness and improve fruit quality in Merlot grapes. In 2008, treatments included: 1) control (unthinned), apical portion of the inflorescence removed at 2) pre-bloom, 3) bloom, or 4) post-bloom, and 5) half the clusters removed at bloom. In 2009, the pre-bloom treatment was replaced with crop removal at shoot thinning (day of year 142 or pre-bloom). In both years, yield was significantly reduced by crop removal, while inflorescence length reduction did not affect yield. Reductions in inflorescence length during or after the bloom period reduced final rachis length when compared to the control, and this increased cluster compactness in both years. Fruit composition (soluble solids, pH, and titratable acidity) was not affected in 2008, but soluble solids and pH increased for the crop removal treatment over the control in 2009. Merlot grapevines appeared to compensate for the inflorescence length reduction by setting more fruit per unit cluster length, negating our hypothesized reductions in cluster compactness. Crop reductions at shoot thinning or removal of half the crop at bloom were the most effective time period to decrease cluster compactness, a technique which growers can easily use to improve cluster architecture in compact varieties.

### **(261) Nitrogen Rate and Form Affects Growth and Yield of Southern Highbush Blueberry in Pine Bark Beds**

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Two southern highbush blueberry (SHB) cultivars, 'Emerald' and 'Jewel', were used to study the effects of three nitrogen fertilization rates and two nitrogen forms on growth and berry yield. The SHB cultivars were grown in 0.9 m wide by 15cm deep pine bark beds at the Univ of Florida Plant Science Research and Education Unit in Citra, FL. The planting was established in 2006 and the experiment was initiated in March, 2008. Plant Spacing was 0.91 m in rows and 3.05 m between rows. Randomized complete block designs were used with a fertilizer rate by fertilizer type factorial arrangement of treatments. The two cultivars were not inter-planted and thus represent separate experiments. Treatments were applied to 4-plant plots using one of the center plants as the data plant. Annual nitrogen rates were 54.7 g N/plant, 78.1 g N/plant, and 101.5 g N/plant. For fertilizer type, the N was applied either as ammonium sulfate (AS), or as 50 % AS and 50% sulfur coated urea (SCU). AS is a highly soluble fertilizer whereas, SCU is a slow-release fertilizer. Fertilizer applications were divided evenly into 8 monthly applications beginning in mid-February and continuing through September. All applications were applied by hand. Phosphorus, potassium and micronutrients were applied at equal rates to all plants per current recommendations. Irrigation was applied daily using micro sprinklers and was based on a function of evapotranspiration. Fruit was harvested every 3-4 days beginning in early April and continuing through May. Canopy volumes were measured at the end of each growing season when plants were dormant. There were no effects of fertilizer rate or type on fruit yield during 2008 or 2009. In winter of 2008-2009 moderate freeze damage to flowers and broken canes from excessive ice loads during freeze protection may have reduced yields and masked treatment effects. Emerald canopy volume measured in Feb. 2010 showed a rate x type interaction. For AS, canopy volume increase was curvilinear with increasing N rate. For SCU there was no effect of N rate on canopy volume. Jewel canopy volume was not affected by fertilizer rate or type

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