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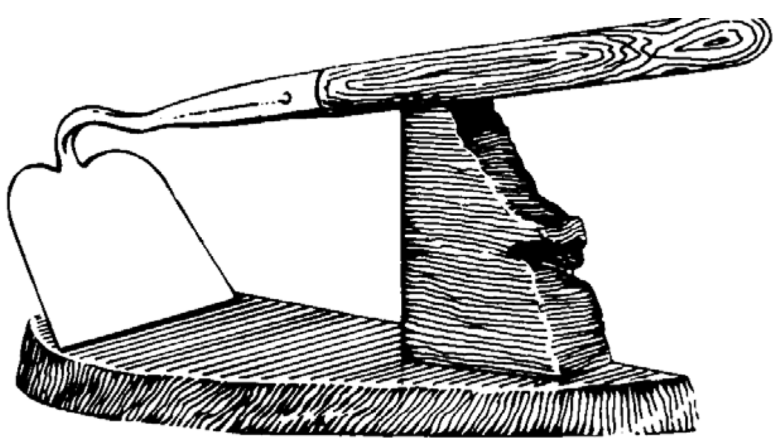
CALIFORNIA WEED SCIENCE SOCIETY

"New Challenges and Opportunities for Weed Management in California"

HYATT SACRAMENTO
Sacramento, California

January 23, 24, & 25, 2019



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Preface

The proceedings contain contributed summaries of papers and posters presented at the annual conference, year-end financial statement, award winners, sponsors, exhibitors, and names, addresses and email addresses given by permission of those attending the meeting.

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CWSS 2019 AWARD RECIPIENTS

Presented by Maryam Khosravifard, CWSS Past President

This year's recipients have made tremendous contributions to the society mission in the following areas: the information exchange through research, publications, facilitating cooperation among individuals, encouraging careers in weed science, and promoting professional growth of members.

Award of Excellence – Scott Oneto, UCCE Farm Advisor/County Director

Scott has been a member of the California Weed Science Society since 2002. Scott has been involved with the society in various capacities. He served as a session chair for the annual conference in the forestry, range and natural areas for several years. He also served on the Board of Directors from 2015 – 2018 as the student liaison. During this time, he increased student participation in both the oral and poster competitions and improved student engagement from junior colleges.

I am honored to present the CWSS award of Excellence Recognition to Scott.

Award of Excellence – Josie Hugie, Ph.D, Branded Technologies Data Manager, Wilbur-Ellis Company

Josie has long track record of enthusiasm for learning, sharing knowledge, and agriculture as a whole.   With a passion for applied research and a strong interest to help support a high-quality field research program, she has served as a CWSS Director promoting sponsorship and exhibition opportunities at annual conferences. Her continued and sustained contribution to CWSS has ensured membership interaction, application of new technologies, and professional growth of our members.

I am proud and honored to present Josie the CWSS award of Excellence.

Honorary Member – Steven Fennimore, Ph.D, Extension Specialist, UC Davis

I really don't need to say a lot about Steve's worth to CWSS. His foot print is well established and is all over his publication, Principles of Weed Control 4th Edition. His decades of service in multiple capacities, including serving as society President, has furthered the mission of CWSS. His enthusiasm for research to incorporate application of new technologies in weed management, and sharing his knowledge and unconditional commitment to step in and help, has made us better scientists and pest managers. It's truly my honor to present the CWSS honorary status to Dr. Steven Fennimore.

2019 CWSS STUDENT PAPERS

Pictured left to right: Alex Ceseski, Katie Driver, Mikayla Loucks, Liberty Galvin, Steven Haring, Whitney Brim-DeForest, CWSS Director. Not pictured: Maribel Portilla

Student Paper Award Winners

Presented by Whitney Brim-DeForest, CWSS Director

1st Place – Alex Ceseski, University of California, Davis
Drilling depth effects on crop stand and weed control in California rice.

2nd Place – Liberty Galvin, University of California, Davis
Flooding depth and burial effect on emergence of five California weedy rice biotypes.

3rd Place – Katie Driver, University of California, Davis
Bearded Sprangletop flooding tolerance in California rice.

2019 CWSS STUDENT POSTERS

STUDENT POSTER CONTEST AWARDS

Presented by Whitney Brim-DeForest, CWSS Director

1ST Place Tie – Idalia Navarro, California State University, Fresno
Effect of moisture and salt stress on germination of bindweed (Convolvalus arvensis L.)

1st Place Tie – Drew Wolter, University of California, Davis
The management & control of Eleusine tristachya in Califronia Orchards

2nd Place – Priyanka Chaudhari, California State University, Fresno
Characterizing the expression of candidate genes for herbicide resistance in the agricultural weed hairy fleabane (Erigeron bonariensis).

In Memorium
Wesley Raymond Croxen
August 30, 1954 ~ June 2, 2018

With great sadness, we wanted to inform you that our friend and colleague Wes Croxen passed away after a long and courageous battle with Leukemia.

Wes served as Alligare's acrolein (MAGNACIDE™ H) technical specialist since 2010. Prior to joining Alligare, Wes worked for Baker Petrolite for 11 years. He was a long-time member/Director of California Weed Science Society (CWSS) and served the western aquatics industry for many years. Active in his community. Wes was a member of Madera County Search and Rescue, a commander of Sons of the America Legion Squadron 11, an Elk member, and served many years as a Boy Scout leader. He enjoyed volunteering his time to help others.

Wes is survived by his wife of 35 years, Marianne Croxen, his children Jesse & Cassie Croxen and Michael Croxen, and five grandchildren.

Nitrogen Deposition, Exotic Grass Invasion and Fire in Coastal and Desert Shrublands of California.
Edith B. Allen, UC Cooperative Extension, Department of Botany and Plant Sciences, University of California, Riverside 92521, edith.allen@ucr.edu

Anthropogenic nitrogen (N) deposition inadvertently fertilizes wildlands downwind of urban and agricultural areas globally. The ecosystem effects of N deposition ranging from 2 to 20 kg/ha/yr were examined in coastal sage scrub and desert scrub in southern California. As another test of N impacts, vegetation plots were also fertilized with ammonium nitrate in sites of low deposition. N deposition caused decreased richness and cover of native forbs and increased cover and biomass of invasive exotic grasses in sage scrub and desert. Open-canopy inland sage scrub and desert scrub were more sensitive to N deposition than closed-canopy coastal sage scrub, with greater grass invasion and native forb decline and increased vegetation type conversion in the inland site and the desert. N fertilization and deposition increased exotic grass biomass to values above the threshold to carry fire across the landscape in both vegetation types. Critical loads (the amount of N deposition above which there are negative ecosystem impacts) for decreased native species richness and vegetation type conversion to exotic grassland occurred at 10-11 kg N $ha^{-1}yr^{-1}$ in sage scrub and 3-9 kg N $ha^{-1}yr^{-1}$ in desert scrub. Critical load values can be used to legislate levels of N deposition to help reduce fire size and frequency and to protect plant diversity.

Role of Invasive Plants in Post-fire Succession of Coastal Sage Scrub: A Case Study Detachment Fallbrook.
Dawn M. Lawson, U.S. Navy's SPAWAR SSC Pacific, Code 71750, 53560 Hull Street, San Diego, CA 92152-6310; dawn.lawson@navy.mil, Lisa R. Ordoñez, U.S. Navy's SPAWAR SSC Pacific, and Christy M. Wolf, Naval Weapons Station Seal Beach, Detachment Fallbrook

Invasive species include a number of functional types that influence both plant communities and ecosystem processes and threaten post-fire community recovery in several ways. Invasives can reduce native shrub species recruitment and establishment through competition with light and moisture. Invasives can promote short fire intervals by creating continuous, flammable fuel beds that promote fire ignition and spread. In FY14, on Naval Weapons Station Seal Beach Detachment Fallbrook, fires burned 70% of the installation's coastal sage scrub. This community is habitat for multiple sensitive species, including the federally listed threatened California gnatcatcher (*Polioptila californica*), but is also subject to seasonal disturbance from cattle grazing. The installation has a robust weed management program that relies on multiple strategies, including post fire control of perennial weeds, monitoring annual weeds, and maintaining an awareness of population dynamics as a basis for effective adaptive management strategies. The installation regrouped, reprioritized goals and strategies, and successfully responded to the fires. In terms of invasive species they mitigated the risks and took advantage of the opportunities presented by the fires in a cost effective response.

The Longevity of a Controlled Burn's Impacts on Species Composition and Biomass in Northern California Annual Rangeland During Drought.

Josh S. Davy, University of California Cooperative Extension, Red Bluff, CA, 96080, jsdavy@ucanr.edu

Controlled burning timed in early summer can dramatically change the species composition of annual rangeland the following season. Although this has been well documented, the longevity of these shifts has not. Presented is a case study of a single 200 hectare burn to begin to understand how long plant communities and biomass production remain diverged between burned and unburned annual rangeland. Species composition and biomass production were monitored before and for three years after burning. Burning drastically reduced medusahead (*Taeniatherum caput-medusae;* $P<0.01$) the following year from 69% in the control to 4% cover in the area burned. In the same year, filaree (*Erodium spp;* $P<0.01$) filled in the area left vacant, subsequently lessoning production ($P<0.01$) in the burn area by over half that of the control. No difference existed in the occurrence of native wildflower species due to fire. Three consecutive drought years following the burn shifted the control from medusahead dominance to filaree in a linear fashion. At the same time, in the burned area medusahead cover increased fourfold between one and three years after the burn. By three years post-burning the burned area had 4% more medusahead cover than the control and was equal in filaree, rose clover (*Trifolium hirtum*), and soft brome (*Bromus hordeaceus*) cover. Our results suggest that a controlled burn followed by drought can cause the divergence in species composition and production to become void in as little as three years after a well-timed burn in a low elevation annual rangeland system.

Concepts of Prescribed Burning: Pyrophilous Species, Natives, and Invasive Weed Management.

Mikayla Loucks, California State University, Chico

The infrastructure of the invasive weed bank in California is very large, contributing heavily to the infestation of 6-7 million acres of National Forest System land. Several facets have led to its exponential increase including mismanagement. This rise is leading to decreased habitat for native vegetation in our shrubland and forest ecosystems. The reduction of prescribed burning in California has, in part, led to the decrease in habitat (Bastach). With many of our National Forest Systems, several native pyrophilous species exist and rely on fire (Bastach). Fires also benefit native species by decreasing competition, eliminating invasive weeds, and opening up water resources.

Bastasch, M. (2018).Decades of Mismanagement Turned U.S. Forests Into 'Slow-motion Time Bombs.' https://dailycaller.com/2018/08/08/mismanagement-forests-time-bombs/.
Accessed Nov. 17, 2018.

Invasive Weed Management and Mosquito Control.

Maribel A. Portilla, University of California, Davis

In the California Delta Region, invasive aquatic weeds are managed with herbicides in order to reduce their negative impacts on the water ways. Herbicides create a dynamic environment of living and decomposing plant matter which affects not only larval mosquitoes, but other invertebrate aquatic life, such as predators and competitors. We studied the effects of herbicide management of water hyacinth on larval mosquito abundances in replicated pond mesocosms. We sampled weekly for mosquitoes and other aquatic invertebrates in mesocosms with water hyacinth, water hyacinth treated with glyphosate and adjuvant (Round-up Custom and Agri-Dex), open water, and water treated with glyphosate and adjuvant. Early in the study, there was a trend for more larval mosquitoes present in water tanks than in water hyacinth. Addition of herbicide resulted in an immediate decrease of larval mosquitoes recoverable through dipping. Larval mosquitoes became most abundant in mesocosms with herbicide-treated hyacinth as decay progressed, and very few larval mosquitoes were recovered in the other habitat-treatments. The number of predatory and competitor insects found rarely varied within and between treatments. With better information regarding the effects of herbicide-use for invasive weed management on larval mosquitoes, integrated management practices for both larval mosquitoes and invasive weeds may be possible.

Drilling Depth Effects on Crop Stand and Weed Control in California Rice.

Alex Ceseski*, A.S. Godar, M.E. Lee, K Al-Khatib, University of California, Davis.
*Corresponding author (arceseski@ucdavis.edu)

California rice has been grown almost exclusively under an aerially-seeded, continuous-flood system for almost a century. However locally adapted grasses and sedges can escape flooding, and the efficacy of the limited palette of available herbicides has become increasingly imperiled due to the continued development of herbicide resistant weed populations.

Drill-seeding rice is a practice that is common in the US South but that is in very limited use in California. Deep drilling may allow novel methods of weed control, for example early cultivation or the use of burndown herbicides prior to rice emergence. In this way drilling may also aid in weedy (red) rice control.

The present research continues to examine the feasibility of a deep-drilling program for California rice. Previous studies suggested that *cv.* M-209 is better suited to seeding at depths exceeding 1 inch than *cv*. M-206. Therefore, a field study was conducted to evaluate weed control and compare crop performance of rice cultivars M-206 and M-209 when drilled at 1 inch and 2 inches and treated with four herbicide regimes using Regiment (bispyribac), Command (clomazone), and/ or Prowl (pendimethalin). Weed control for all treated plots hinged on using glyphosate as a postplant-preemergence burndown treatment prior to using other herbicides.

Late-emerging sprangletop necessitated the use of Clincher (cyhalofop) as a cleanup treatment. Weed control was excellent for all treated plots, with essentially zero weeds/ sqft. Glyphosate applied just as rice emerged reduced weeds 40-60%. Untreated plots were exceptionally weedy and dominated by watergrasses. Watergrass densities in untreated plots approached 140 plants/ sqft, and there were no differences in weediness between cultivars or seeding depths. Sedges and aquatic weeds were essentially nonexistent in any plots.

Yields were very good for both cultivars across depths, with M-206 averaging 9100 lb/ac, and M-209 averaging 10800 lb/ac. There were no differences in yields between depths for either cultivar. Our field results have thus far indicated that, given proper seedbed preparation, good water management, and good scouting, competitive yields and economical weed control can be achieved with deep-drilling of either rice cultivar in California, though *cv.* M-209 may be more vigorous under less ideal conditions.

Weed-Suppressing Cover Crops in Almond Orchards. SC Haring, C Crézé, A Gaudin, BD Hanson, University of California, Davis

Cover crops have the potential to increase the sustainability and resilience of almond orchards in the Central Valley. By adding winter annual cover crops to orchard alleys, almond growers may increase orchard floor cover, provide pollinator forage, and increase soil organic matter. Furthermore, cover crops may suppress weeds by effectively competing for water, light, and other resources, thereby replacing unknown resident vegetation with domesticated plants. We planted two five-species mixtures of cover crops in commercial almond orchards in Tehama, Merced, and Kern Counties and monitored orchard floor vegetation with point intercept transects. In late winter, both cover crop mixes effectively reduced weed populations and bare orchard floor compared to standard (i.e. no cover crop) treatments, though this effect was dependent on successful cover crop establishment. Sites with reduced cover crop establishment resulted in relatively less weed suppression. No difference was observed between treatments at harvest time, indicating that standard management practices (e.g. burndown herbicides, mowing) resulted in effective cover crop termination. Future research will study management factors, such as planting date and rate, termination timing, and irrigation, that contribute to a successful cover crop in almond orchards.

Bearded Sprangletop Flooding Tolerance in California Rice. Katie E. Driver*, Amar Godar, Alex Ceseski, Mike Lee, and Kassim Al Khatib. University of California, Davis.
*Corresponding author (kemccauley@ucdavis.edu)

Bearded sprangletop (*Leptochloa fusca* (L.) Kunth ssp. *fasicularis* (Lam.) N. Snow) is a problematic weed in California rice production. Flooding was thought to suppress bearded sprangletop growth, however after many years of continuous rice production, anecdotal evidence suggests that bearded sprangletop populations can tolerate flood pressures. A study was conducted over two years at the Rice Research Station in Biggs, CA to test the flooding tolerance of two populations against three irrigation methods. The study implemented a split block factorial design with sprangletop population being factor 1 and irrigation method being factor 2. The irrigation methods were 1) 4 in. (10 cm) continuous flood; 2) 8 in. (20 cm) continuous flood and; 3) 2 in. (5 cm) flood. The two bearded sprangletop populations tested consisted of one clomazone resistant and one susceptible population. There was no emergence of bearded sprangletop in the 8 in. flood depth of either population. With a continuous 4 in. flood, only the resistant population survived flooding pressure and produced significantly more tillers and seed than any other treatment-population combination tested. This suggests that there may be a fitness advantage related to clomazone resistance, however further testing is needed to confirm this.

Flooding Depth and Burial Effect on Emergence of Five California Weedy Rice Biotypes. **Student presenter:** Liberty Galvin, University of California, Davis
Contributing Authors: Whitney Brim-DeForest, Mohsen Mesgaran, Kassim Al-Khatib, University of California, Davis

Weedy rice (*Oryza sativa*), a common pest in the Southern United States, has recently become a significant weed in California rice production systems. There are five genetically distinct weedy rice accessions that are unique to California, but are virtually undetectable in grower fields due to their conspecific features with cultivated rice (*Oryza sativa* L.). Competition studies illustrate that weedy rice matures faster than cultivated varieties, providing a short, pre-season window for control. To determine best management practices for reducing in-field abundance, an emergence experiment was conducted under controlled conditions. Treatment combinations of four flooding depths at 0, 2, 4, and 6 inches as well as four burial depths, 0.5, 1, 2, and 4 inches were applied in combination, respectively, to the five weedy rice accessions as well as 'M- 206' rice (medium grain, median maturity) for comparison. A randomized complete block design was used with four experimental replicates per trial; three trials were conducted through the growing season from June through August. Each trial lasted 21 days with emergence counted daily, water and air temperature logged hourly. Plants were harvested and average biomass was calculated from biotype by block. Data was subjected to an ANOVA and Tukey test to determine the significance ($p \leq .05$) of each treatment as well as any interactions between treatments. Results revealed that burial depth played a significant role in emergence of all accessions with emergence decreasing with increasing burial depth. All rice accessions were unable to emerge from depths at or below 2 inches. There was no significant effect from flood, nor was there a significant difference between the emergence rates of weedy rice accessions. This research indicates that emergence of California weedy rice accessions can be prevented by tilling seeds into the soil to or below 2 inches.

Keywords: accessions; conspecific; emergence

Bench Scale Trials to Effective Full Scale Cyanobacterial Management with Liquid Activated Peroxygen Algaecide/Cyanobactericide. Tom Warmuth, Lake, Pond and Municipal Representative, 336-402-4449, 22 Meadow St, East Hartford, CT 06108 1.888.273.3088 | biosafesystems.com

Development of effective treatments for cyanobacterial management are needed as the threat to our water resources by these organisms becomes more realized and understood. The need for tools to cyanobacteria known to produce harmful toxins and taste and odor compounds is an important ongoing focus in the field of surface water management. Bench Scale trials at Clemson University on bloom level densities of cyanobacteria (1.9 million cells/ml) lead to effective field application rates in full-scale surface treatments of a municipal potable water sources.

Irrigation District Aquatic Vegetative Management: Testing Endothall Rates and Durations for Optimum Performance. Cory Greer, Account Manager – Aquatics, United Phosphorus, Inc., Pasco, WA (cell) 208-490-7654 Cory.greer@uniphos.com, www.upi-usa.com

Irrigation Districts in Washington State, and throughout the West, are mandated by their respective National Pollution Discharge Elimination System permits to reduce some key chemical discharges to waters of the United States. Under some of these permits a use reduction plan, in heavy metals like copper and additional chemicals like Acrolein, is required as continuing environmental stewardship. New and innovative ways to use the available aquatic vegetative management chemicals is needed to meet these goals. Work in South Columbia Basin Irrigation District in the last 5 years has focused on using Teton (Mono (N,N-dimethylalkylamine) salt of endothall) in different concentrations and durations for optimum performance over the irrigation season in complicated irrigation canals. The results of these trials has led to greater control of problem submerged aquatic species as well as a reduction in algae in the same canals. This talk focuses on the use of Teton as a method to reduce usage of other available chemicals as well as a cost benefit analysis comparison with Acrolein (Magnecide-H).

Endothall Behavior in Five Aquatic Weeds. Mirella F. Ortiz[1], Scott J. Nissen[1], Cody J. Gray[2, 1] Colorado State University, Fort Collins, CO; [2] UPI, Peyton, CO

Endothall is one of the original aquatic herbicides, being used primarily to control submersed plants since 1960. Endothall is considered a contact herbicide and is in a chemical class of its own. It is a serine/threonine protein phosphatase inhibitor which has broad-spectrum control and is effective in controlling both monocotyledons and dicotyledons. Eurasian watermilfoil (*Myriophyllum spicatum* L.) (EWM), hydrilla (*Hydrilla verticillata* (L.f.) Royle), curlyleaf pondweed (*Potamogeton crispus* L.) (CLP), and sago pondweed (*Potamogeton pectinatus* L.) (SPW) are submersed aquatic species considered troublesome throughout the United States which can be controlled with endothall. Although endothall is considered a contact herbicide, many field observations suggest that it might have systemic activity. The goals of this research were to (1) determine herbicide maximum absorption and absorption rate, (2) evaluate herbicide translocation from shoots to roots in EWM, two hydrilla biotypes, CLP, and sago pondweed, and (3) evaluate herbicide desorption in EWM and two hydrilla biotypes. Each weed was clonally propagated from apical shoot cutting or turions/tubers when present. For herbicide absorption and translocation, plants of each species with developed roots and 15 cm of shoot growth were transferred to test tubes and sealed at the top with a low melting point eicosane wax to isolate the root system from the water column. Plants were exposed to the herbicide over a 192 h time course. Herbicide desorption was evaluated over a time course of 96 hours. Hydrilla showed a linear increase in endothall absorption, while endothall absorption in EWM, CLP and sago pondweed best fit an asymptotic rise function. Translocation to EWM, CLP, and SPW roots was limited, reaching a maximum translocation of 8%, 3% and 1% of total absorbed radioactivity, respectively. Monoecious and dioecious hydrilla showed a linear increase without reaching maximum absorption or translocation 192 HAT. Endothall translocation to monoecious and dioecious hydrilla roots was 18% and 16% of total absorbed radioactivity, respectively. Herbicide desorption was less than 30% for all the three species evaluated. These data provide strong evidence that endothall behaves as a systemic herbicide in these aquatic species.

Alternatives to Glyphosate for Aquatic Sites. Stephen Burkholder, Project Biologist, Blankenship & Associates, Inc., 1615 5th Street, Suite A, Davis, CA 95616 Office 530.757.0941

Concerns about glyphosate-resistance developing in target vegetation, the addition of glyphosate to the Proposition 65 list as a carcinogen, and public pressure to stop using glyphosate have resulted in the need to look for alternative products and approaches. This presentation will focus on glyphosate alternatives for aquatic vegetation control in irrigation and non-irrigation sites. The discussion will include metrics to use when evaluating alternative products and review currently registered alternative active ingredients.

Sequential Preemergence Herbicide Programs for Extended Summer Grass Weed Control. Caio Brunharo,[1] Brad Hanson[2]. [1]Oregon State University (Caio.Brunharo@oregonstate.edu), [2]University of California, Davis (bhanson@ucdavis.edu)

Summer grass weed species are becoming more troublesome in orchards in the Central Valley of California. These weed species reach their maximum biomass accumulation late summer/early fall when harvest operations are taking place. A common weed control program in tree nut orchard crops in California consists of a winter preemergence/postemergence herbicide tankmix application, followed by a burndown application in the spring with a postemergence herbicide, and then an additional burndown herbicide application before harvest. Because most of the burndown herbicides have no residual activity (e.g. glyphosate, glufosinate, paraquat) or relatively short residual activity (e.g. oxyfluorfen), weeds that germinate after the spring treatment may still develop during the summer. In this context, season-long weed management strategies become crucial to prevent the development of summer weeds. Sequential preemergence herbicide programs in tree nuts may be an approach to specifically target these species. The idea behind the sequential approach is to apply a second PRE herbicide shortly before germination of the summer species rather than trying to achieve summer weed control with only the PRE herbicides applied in the winter. This approach more specifically targets those summer-emerging species and may at the same time provide economic and environmental benefits by reducing over-treatment. To evaluate this concept, we conducted two field trials in walnut orchards near Tulare County, California, from December 2017 to August 2018. The treatments consisted of a December application of one of three common preemergence herbicides. On top of this, pendimethalin (Prowl H2O) was tankmixed with the December treatment, applied as a sequential treatment in March, or split with part of the pendimethalin treatment applied in December and part in March. The standard herbicides were indaziflam (Alion), penoxsulam/oxyfluorfen (PindarGT) and flumioxazin (Tuscany). At both application timings, glyphosate + glufosinate was added to the preemergence treatments to ensure that all weeds evaluated originated from seed and not from regrowth. Junglerice was the predominant summer weed species at both sites. Junglerice control was evaluated monthly and aboveground biomass was collected in August before trial termination. We observed a general trend that the addition of pendimethalin enhanced junglerice control throughout the crop growing season. Not surprisingly, summer grass control was best with all three winter foundation herbicides when followed with the high rate of pendimethalin (Prowl H2O 4 qt/A) in the spring. A contrast analysis indicates that the addition of pendimethalin to the system (either in the winter or spring) enhance junglerice control, reducing the average biomass of this weed to 181.8 g m-2 (>70% enhanced control). We also observed that a sequential application of lower rates of pendimethalin (Prowl H2O 2 qt/A in winter + Prowl H2O 2 qt/A in spring) provides a better control of junglerice than a single application of the higher rate of pendimethalin (Prowl 4 qt/A) in the winter. Lastly, we observed that the lower rate of pendimethalin applied in the spring actually outperformed the higher rate of pendimethalin applied in the winter. The experiments conducted in this research focused primarily on the control of summer grass weed species, and the weed community present in specific fields will determine the adequate herbicide treatment to be adopted.

Pre and Post-Herbicide Performance on Threespike Goosegrass in Tree Nut Orchards.

Drew Wolter and Brad Hanson. University of California, Davis, Department of Plant Sciences

Abstract
Threespike goosegrass (*Eleusine tristachya*) is related to the more widely distributed goosegrass (*E. indica*). While goosegrass is an erect, large stature annual, threespike goosegrass is a tufted low-growing perennial (or semi-perennial) grass. This species has been identified as an emerging species of concern in California's Central Valley orchard production systems and has shown a high level of tolerance to glyphosate, particularly once established. Field studies were conducted in Chico and Livingston, CA to evaluate the performance of several pre-emergent (PRE) and post-emergent (POST) herbicide control options. Results confirmed that threespike goosegrass is tolerant to glyphosate treatments. The highest level of POST control was with Fusilade. The most efficacious PRE control was obtained through sequential herbicide applications (SHA) of Alion followed by Prowl H2O, which targeted the specific phenology of this species.

Introduction
Threespike goosegrass is a low-growing, coarsely tufted, warm season perennial grass, which has a prominent fold at the mid rib in young leaves that flatten when mature. The most distinguishable attribute of this species is its digitate inflorescence (Fig. 1, left). This species is often misidentified due to its common name and for being closely related to the highly successful invasive, goosegrass; however, there are some major phenological and morphological differences. Goosegrass is a large stature and erect annual with a larger digitate inflorescence, generally having five to eight spikes which are four to fifteen cm long (Fig. 1, right), while threespike goosegrass is a low-growing tufted perennial, which has a more compact inflorescence, and fewer, two to four, spikes which are shorter, typically one to three cm.

Figure 1. Digitate inflorescence comparison- threespike goosegrass (E. tristachya) on the left, goosegrass (E. indica) on the right.

Cause for Concern

This species was first reported in California in 1967. Since then, threespike goosegrass has become a significant concern in almonds and other orchard cropping systems across the Central Valley and growers have observed poor control with glyphosate. Tufted grasses such as threespike goosegrass are particularly problematic in tree nuts because the plants interfere with nut pick up from the orchard at harvest. Previous glyphosate dose response work at UC Davis showed that plants treated at the 2-tiller stage survived up to a 2x rate and when treated a few weeks later, at the 15-tiller stage, they survived up to 16x (Fig. 2)

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Applications:

Treatments were applied to greenhouse grown plants at the 2-tiller (top) and 15-tiller (bottom) growth stage.

Glyphosate rates:

Glyphosate doses ranged from 1/8x (second to left) to 16x (right).

Note: 1 lb ae/A = 1x

(Hanson et al. 2013 Walnut Weed Control Research and Extension: Herbicide Efficacy, Crop Safety, and Glyphosate-Resistant Weed Management in Central Valley Walnut Orchards)

Figure 2. Glyphosate dose response on threespike goosegrass

Objective

To evaluate the performance of several pre-emergent (PRE) and post-emergent (POST) herbicides on threespike goosegrass in order to provide viable control options to California growers, Pest Control Advisors, and the UC Cooperative Extension network.

Methods

Two field trials were conducted in 2018; one at the Chico State University Farm in Chico, CA in a walnut orchard and the other in a commercial almond orchard near Livingston, CA. The trial design was a randomized complete block with four replications. Plots in Livingston were 15 ft by 10 ft with one tree per plot, while plots in Chico were 20 ft by 10 ft with one tree per plot. Herbicide treatments were applied with a CO2 pressurized backpack sprayer, calibrated to deliver 30 GPA at 30 PSI through three TeeJet XR11003 flat fan nozzles. A discharge calibration was performed before application and a metronome was used to maintain travel speed. The herbicide treatments (Table 1 & 2) were applied in a five-foot band on both sides of the tree row.

Data collection included visual assessments at monthly intervals for PREs, starting one month after the January 2018 application and continued for five months. One treatment included an additional PRE-application in March as part of a sequential herbicide program. The purpose of this sequential approach was to apply a second PRE-herbicide closer to germination and emergence of this warm season grass, rather than relying on a single winter application. POST treatments were applied in May 2018 and control assessments were conducted at weekly intervals, starting one week after application for approximately one month. Threespike goosegrass control was estimated using a 0 to 100 scale, where 0 means no control and 100 means plants were completely killed.

Table 1. PRE-emergent treatments*		
Active Ingredient	**Trade Name**	**Rate (product/A)**
indaziflam	Alion	3.5 fl oz
indaziflam	Alion	5 fl oz
penoxsulam + oxyfluorfen	Pindar GT	2 pt
penoxsulam + oxyfluorfen	Pindar GT	3 pt
pendimethalin	Prowl H2O	4 qt
oryzalin	Surflan	4 qt
rimsulfuron	Matrix	4 oz
flazasulfuron	Mission	2.85 oz
indaziflam + rimsulfuron	Alion + Matrix	3.5 fl oz + 4 oz
oxyfluorfen + oryzalin	Goal + Surflan	5 pt + 4 qt
flumioxazin + pendimethalin	Chateau + Prowl H2O	10 oz + 4 qt
indaziflam fb pendimethalin	Alion fb Prowl H2O	3.5 fl oz + 3 qt

* fb = "followed by". Note: AMS (1% v/v), NIS (0.25 % v/v), and Rely 280 (32 fl oz/A) were added to treatments according to label recommendations.

Table 2. POST-emergent treatments*		
Active Ingredient	**Trade Name**	**Rate (product/A)**
sethoxydim	Poast	2 pt
clethodim	SelectMax	12 fl oz
fluazifop	Fusilade	12 fl oz
glyphosate (1X)	Roundup Weathermax (WM)	1 qt
glyphosate (2X)	Roundup WM	2 qt
glyphosate + rimsulfuron	WM + Matrix	1 qt + 2 oz
glyphosate + oxyfluorfen	WM + GoalTender	1 qt + 0.5 pt
glyphosate + glufosinate	WM + Rely280	1 qt + 2 qt

* Note: NIS (0.25 % v/v) **OR** MSO (1% v/v) were added to treatments according to label recommendations.

Results

PRE: Since threespike goosegrass can emerge from April through August, a long-persisting pre-emergence herbicide program is needed. The most effective PRE applied to threespike goosegrass in this study was the sequential herbicide application of Alion followed by Prowl H2O, which provided 90% control five months after the initial treatment (Fig. 3). The single product treatments of Prowl H2O @ 4qt/A, Pindar GT@ 3pt/A, and Alion @ 5oz/A, all provided greater than 72% control five months after treatment (MAT). All other treatments had less than 68% control five MAT (Fig. 4).

POST: Graminicides such as Fusilade, SelectMax, and Poast, all controlled tillered *E. tristachya* greater than 75% five weeks after treatment (WAT). Fusilade provided greater than 92% control five WAT. Glyphosate applied at a common field rate, and twice that rate, proved to be the least efficacious, with less than 54% control five WAT. Tank mix treatments of glyphosate plus another herbicide had varying level of control five WAT, including glyphosate + rimsulfuron (37% control), glyphosate + oxyfluorfen (56% control), and glyphosate + glufosinate (67% control), all shown in Fig. 5.

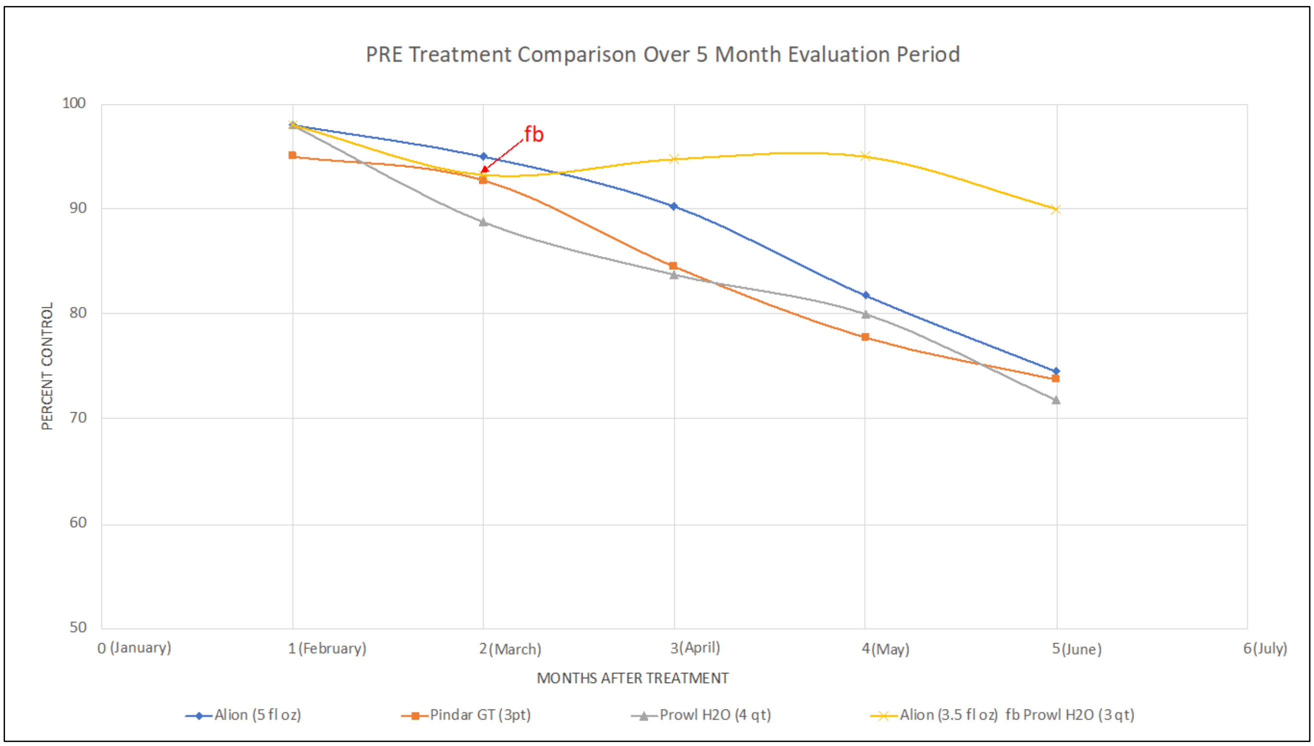


Figure 3. Comparison of average residual periods obtained by single products vs. sequential herbicide treatments (fb) on threespike goosegrass from both locations.

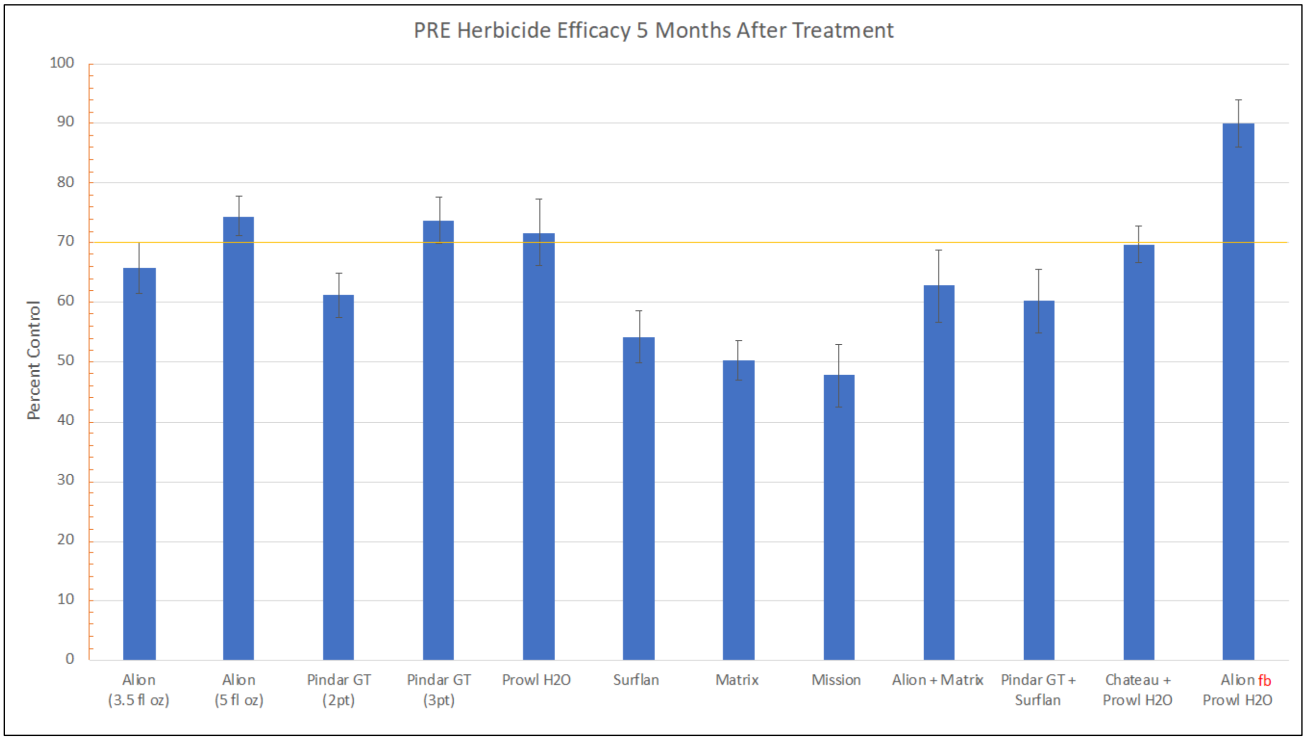


Figure 4. Control of threespike goosegrass five months after treatment with PRE herbicides. Data are averages of two orchard locations.

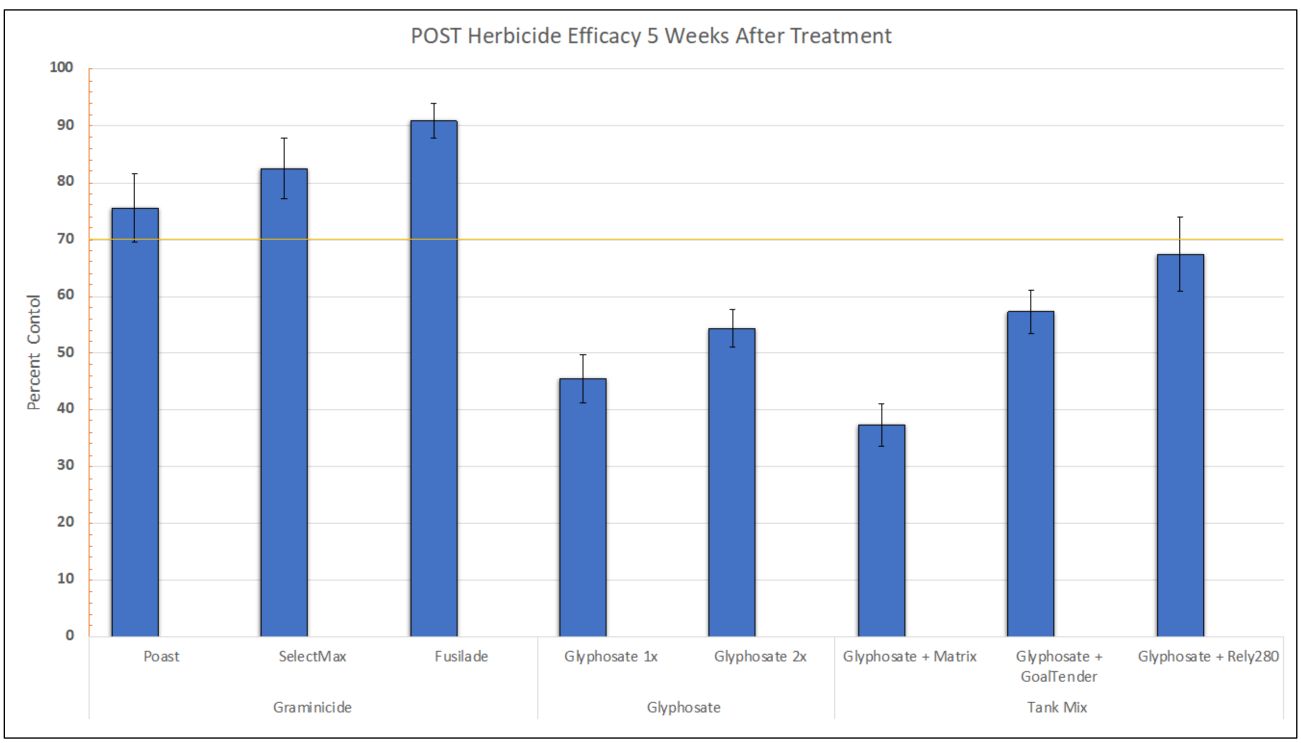


Figure 5. Control of threespike goosegrass five weeks after postemergence treatments. Data are averages of two orchard locations.

Conclusion

PRE: Multiple herbicides in these trials, including Alion, Prowl H2O and Pindar GT, provided adequate control of seedling threespike goosegrass. The greatest control of this warm season perennial was obtained with the sequential application of Alion followed by Prowl H2O, presumably due to the second application made closer to the spring and summer germination. Results from this study suggest that a management plan utilizing a PRE-herbicide applied later in the spring may minimize seedling recruitment of this species.

POST: Data collected in the 2018 field trials confirmed that threespike goosegrass is extremely tolerant to glyphosate. Even when Roundup Weathermax was applied at the higher rate of 2 qt/A, threespike goosegrass control did not exceed 54% and many plants recovered and later produced new shoots and panicles (Fig. 6). The graminicides tested, Fusilade, SelectMax, and Poast provided the greatest POST control of threespike goosegrass. Of these, Fusilade provided the greatest level of control in this study, resulting in up to 92% control five WAT (Fig. 7).

Figure 6. Threespike goosegrass 3 weeks after a 2 qt/A Roundup Weathermax treatment. Plant exhibits regrowth and ability to flower.

Figure 7. Heavily tillered threespike goosegrass 5 weeks after Fusilade treatment. Full necrosis achieved.

Common Orchard Crop Herbicide Injury Symptoms and Common Contributing Factors. Brad Hanson, UC Cooperative Extension Specialist, University of California, Davis (bhanson@ucdavis.edu)

Herbicides can provide an amazing level of weed control in many situations; however, they can also cause unexpected crop injury in some cases. It is really important to remember that most orchard herbicides can injure tree crops – crop safety is mostly a function of placement (above the roots and below the canopy). This presentation focused on some of the most commonly observed crop injury issues in California orchard crops and some contributing factors.

When diagnosing herbicide injury, it is important to think about the symptoms observed and the kinds of symptoms might be expected from various mode-of-action herbicides. Also, consider where the symptoms occur; both within the field and within an affected plant – these can be important clues as to what might have happened. For example, a strong pattern of injury within a field such as whole rows affected, or areas coinciding with the sprayer tank size would suggest different potential causes than if one edge of the field were affected and symptoms faded as you move into the field (e.g. potentially a misapplication vs drift from outside). Similarly, drift of a contact herbicide would likely cause very different symptoms than inadvertent exposure to a translocated herbicide (e.g. old tissue affected but new tissue unaffected vs the opposite).

Avoiding crop injury, or at least minimizing the risks, should be an important goal of growers and advisors who make decisions about herbicide programs. First, a good weed control plan should be based on knowledge of the site and weeds to be controlled. Field scouting, a year-round IPM approach, and an understanding of the crop age and architecture all provide important information on what is needed to control and some of the risk factors to be mitigated. Similarly, understanding of general soil types as well as any unusual areas with regard to texture, organic matter, or topography might be important considerations that affect the potential risks from soil-applied herbicides. Once a good plan is developed, it is crucial to implement it well. Sprayer calibration, sprayer setup, operator training, and mixer/loader training all are areas where a good plan can be poorly implemented and lead to overdoses and potential crop injury. Lastly, the applicator or person writing the pesticide recommendation should use some caution, particularly with more recently-registered herbicides because it is simply not possible for every permutation of crop/rootstock, soil type, irrigation system, weather condition to have been evaluated during the registration process. It may be a good idea to get a sense of how it work on a smaller scale, in multiple locations, at more modest rates, and with various tankmix partners before going “all in” on adopting any new herbicide technology.

A great deal of research goes into developing herbicide uses for labeled crops to ensure rates and use patterns will allow good crop safety and performance. However, crop injury can and does occur on occasion. Effective - but not excessive - weed management plans can help avoid over treatment, implementing the plan well include appropriates recommendations and accurate applications, and knowledge of the site are all important contributors to minimizing the risk of orchard crop injury. When injury does occur, consider the symptoms, the herbicide modes of action, and potential routes of exposure. A great resource for comparing herbicide crop injury symptoms can be found at: http://herbicidesymptoms.ipm.ucanr.edu/

New Opportunities to Manage Herbicide Resistant Weeds in California. K. Al-Khatib and A. Godar, University of California, Davis.

Herbicides continue to be the most important component of any weed management program in California rice fields. With the excessive reliance on a few herbicides and lack of crop rotation, however, several weeds in rice fields have evolved resistance to herbicides including California Arrowhead, Smallflower Umbrella Sedge, Ricefield Bulrush, Breaded Sprangletop, Late and Early Watergrass, Barnyardgrass and Redstem. In California, rice has more herbicide-resistant weeds than any other crop or region in the United States that result in more complex and expensive weed management program. Currently, there are eight modes of action herbicide labeled for use in California rice accounting for 15 herbicide labels in total. Alarmingly, to date weed species of California rice have evolved resistance to five different herbicide modes of action. Several weed populations develop multiple resistance to more than two different modes of action herbicides. Currently, there is no weed resistance developed to Protox-inhibiting herbicides (carfentrazone), synthetic auxin herbicides (triclopyr) and HPPD-inhibiting herbicides (benzobicyclon). Three new herbicides including pyraclonil, florpyrauxifen, and New FMC grass control herbicide are in the development pipeline for weed control in rice. These herbicides may play major roles in managing herbicide resistant weeds in California rice fields. The weed science program at the University of California has tested these three compounds in order to help growers using these products when they will be available.

Pyraclonil is a Protox-inhibiting herbicide from Nichino America Inc. that has a similar mode of action to Shark (Carfentrazone). A rate and timing studies conducted at the rice experiment station at Biggs, CA showed that this compound has excellent activity on smallflower umbrella sedge, barnyardgrass and watergrass. It also has good activity on ducksalad and other broadleaf weeds. It demonstrated excellent crop safety when applied at 1-leaf stage of rice.

Florpyrauxifen (Loyant) is an auxin type herbicide that has activity on grasses, sedges and broadleaf weeds. Our research showed that Florpyrauxifen has broad time window of application unlike most of other rice herbicides. It has good activity on barnyardgrass, watergrass, Smallflower umbrella sedge, redstem, ducksalad, and rice flatsedge with excellent crop safety. In general, florpyrauxifen is a promising tool for weed control in California rice but also will be excellent addition to control herbicide resistant watergrass and smallflower sedges.

A new FMC herbicide. It is mainly a grass control herbicide that can be used at low rates. It has broad time window of application compare to other grass control herbicides. In addition, it has novel mode of action that can be extremely helpful to manage herbicide resistant grasses. The herbicide has excellent safety on rice with outstanding grass control.

Weed Emergence Timing in California Rice. Driver K.E. and K. Al-Khatib, University of California, Davis

Herbicide application timing is vital to the efficacy of herbicides. Due to the spectrum of weed emergence in a single field, it is difficult to target all weeds present. Many weed species escape application and are thought to be resistant when the failure in control was a mis-timed application. To get a better understanding of emergence times of common problematic weed species in California rice fields, a field study was conducted at three different sites throughout the Sacramento Valley with planting dates ranging from April 26 to June 1. The weed species smallflower umbrella sedge, barnyardgrass, and bearded sprangletop were planted in controlled

PVC rings. One hundred seed of each species was planted in a row and marked. Emergence counts were taken daily at each site. The data was then modeled into a predictive thermal time model to estimate weed emergence timing. The emergence model used was able to calculate the base temperature for emergence, as well as how many growing degree days (GDD) were needed for emergence. Smallflower umbrella sedge had a base temperature for emergence of 62 °F and a lag phase of 9 GDD. Barnyardgrass had a base temperature for emergence of 58 °F and a lag phase of 13 GDD. Bearded Sprangletop had a base temperature for emergence of 57 °F and a lag of 64 GDD. Using this data, smallflower umbrella sedge emerged first in each field at approximately 5 days after flooding, followed by barnyardgrass which emerged approximately 5-10 days after flooding, and lastly bearded sprangletop which emerged 15 – 35 days after flooding. The differences in emergence times indicate more than one herbicide application time may be needed to control the spectrum of weeds present.

Pyraclonil: A New Herbicide for Weed Control in California Rice.

Jose Gutierrez, Product Development Representative, Nichino America jgutierrez@nichino.net

On April 2017, Pyraclonil was licensed to Nichino America Inc. by the Japanese company Kyoyu Agri. Nichino America Inc. first began work with Pyraclonil in California in 2013 to develop this compound under California rice growing conditions. An into the water 1.8% active ingredient granule was developed, that was best suited to be applied by air. The recommended rate of Pyraclonil is 14.9 lb/a (300 g ai/ha) with a day of seeding application timing. At this rate and timing, suppression (approximately 75% to 100% control) of *Echinochloa spp* (early and later water grass), suppression (approximately 75% control) of *Scirpus mucronatus* (rice field bulrush), control of *Cyperus difformis* (smallflower) and control of all the major broadleaf weeds has been observed. At harvest yield evaluations have shown that plots treated with Pyraclonil are not negatively impacted. It is anticipated that Pyraclonil will received a California registration in 2021.

Management Tactics for *Dittrichia graveolens*, AKA Stinkwort.

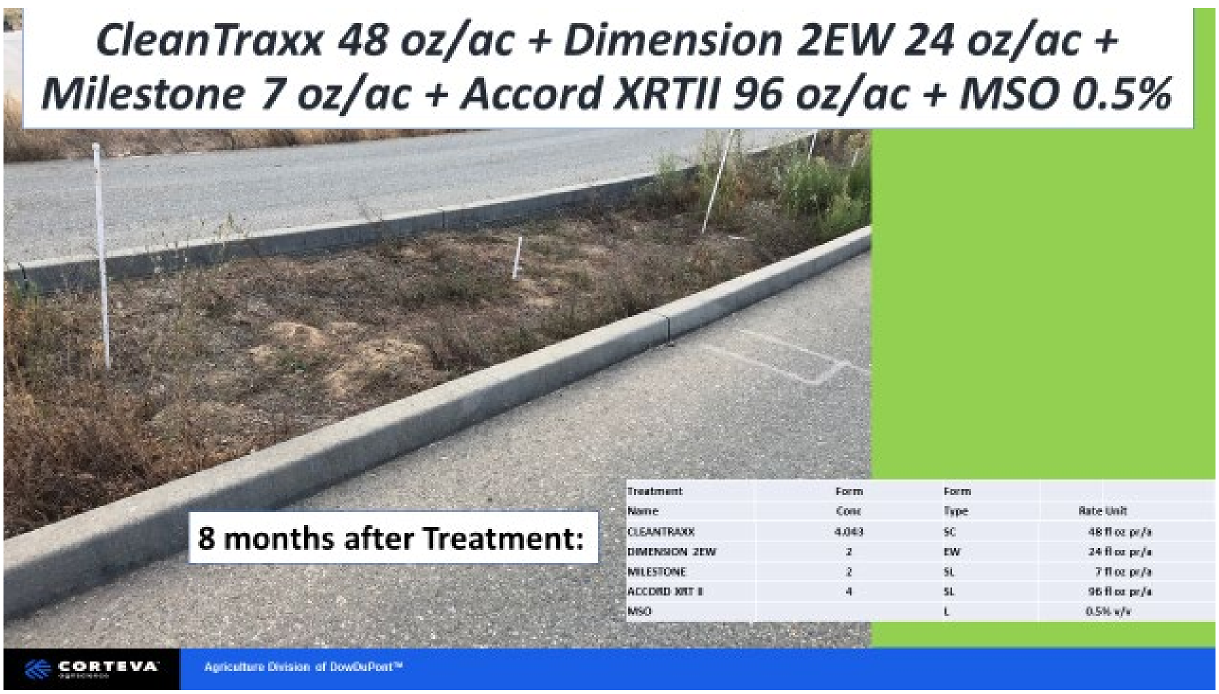
Richard W. Miller, Corteva agriscience. Richard.miller@corteva.com

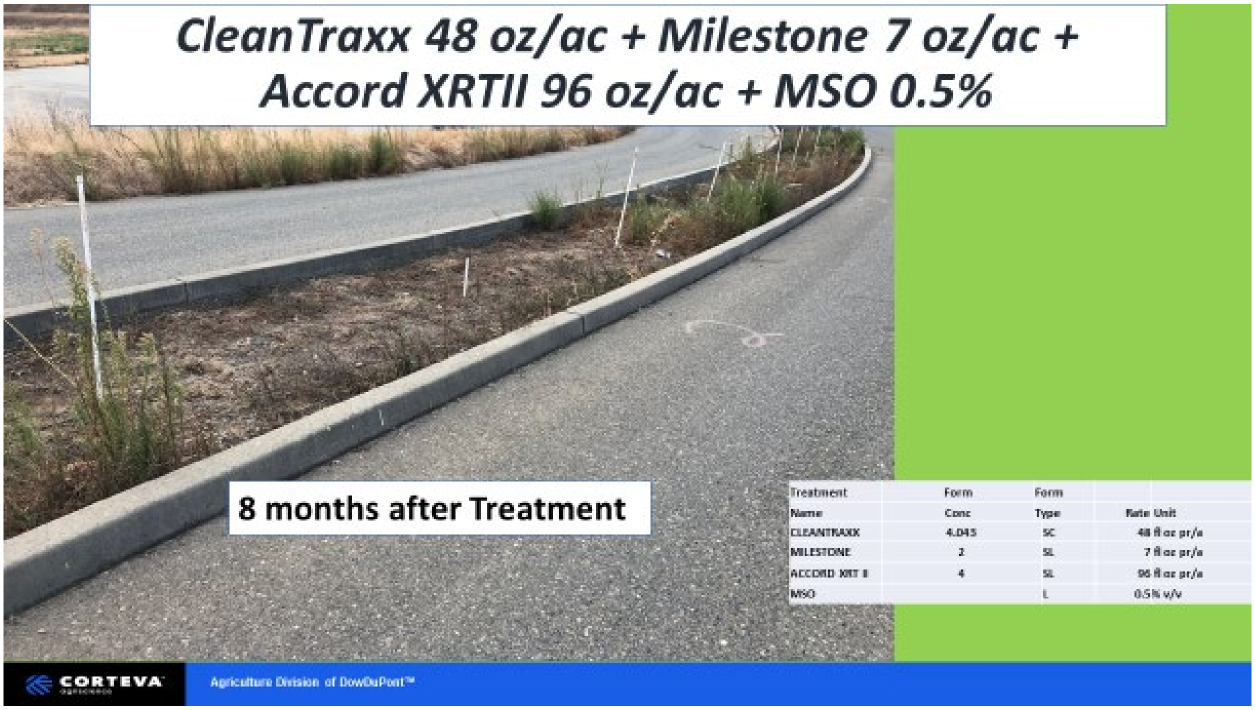
Dittrichia graveolens, also known as stinkwort and native to the Mediterranean, is one of the most invasive weed species to infest California since Russian thistle (*Salsola spp.*) invaded the west over 100 years ago (J. DiTomaso, verbal communication). First detected in Santa Clara County in 1984, traits of this late-season winter annual allowed it to spread quickly and relatively undetected until it was recognized in widespread areas of California. By 2012, stinkwort was established in at least 36 of 58 counties in California (Consortium of California Herbaria 2012). Due to its nondescript growth and tendency to bolt later than many winter annuals, stinkwort is sometimes confused with Russian thistle or a number of native tarweed species. Taxonomically, stinkwort is more closely related to the cudweeds (DiTomaso and Healy, 2007). In addition, stinkwort flowers and produces seed later in the year from September through December. Seeds can germinate immediately as there is apparently no dormancy, but will grow cryptically as small non-distinct rosettes for most of the spring. Stinkwort is also unusual in that it bolts later in the year, mid-May through September (Brownsey, et. al. 2013). It favors disturbed soils along roadsides and other rights-of-way as well as rangeland and natural areas. One of the distinguishing features of stinkwort after it has bolted is its pungent odor due to the production of borneol and related aromatics, reminding the author of "Vick's VapoRub". Stinkwort may be toxic to livestock and causes a rash in some people, so protective gear (long- sleeved clothing and gloves) is recommended when hand-weeding.

In a replicated study applied in late June 2009, treatments containing at least 24 oz/acre acid equivalent triclopyr (3 pints/acre Garlon®4 Ultra or Vastlan® or 4 pints/acre Garlon 3A), were most effective at controlling stinkwort. Aminopyralid and aminocyclopyrachlor, as individual treatments, did not control stinkwort in this pre-flowering trial (Brownsey, et. al. 2013). In subsequent demonstration trials, winter applications of aminocyclopyrachlor (Method™) and spring applications of aminopyralid plus triclopyr (Capstone® 8 pints/acre) showed the greatest potential for controlling stinkwort. Early-season application of glyphosate alone, however, controlled competing vegetation and thus allowed late-germinating stinkwort to thrive (Brownsey, et. al. 2013). The author also has seen Capstone (8 pints/acre) control late season flowering stinkwort in several range and pasture sites in California.

A non-replicated herbicide trial was applied on April 5, 2018 in a narrow roadway median previously infested with stinkwort by Will Hatler, Field Development Biologist for Corteva agriscience in Sacramento County with a CO_2 powered backpack sprayer. Stinkwort rosettes were present on the day of application. All treatments included 96 oz/acre Accord® XRTII and 0.5% MSO (v/v), therefore this study focused on the pre-emergent effects of combined herbicide mixes on stinkwort that might have germinated after treatment. As the evaluations are still underway, the most recent December 2018 evaluation showed that all tested pre-emergent combinations provided 100% visual control of stinkwort and other weeds that may have been present (8 months post-treatment). These herbicide tank mixes are commonly used in various non-crop use sites, including rights-of-way. Treatment 1: Spike® (20 oz/ac) plus CleanTraxx® (32 oz/ac) plus Milestone® (7 oz/ac). Treatment 2: CleanTraxx (48 oz/ac) plus Milestone (7 oz/ac). Treatment 3: CleanTraxx (64 oz/ac) + Dimension® 2EW (32 oz/ac). Treatment 4: CleanTraxx (48 oz/ac) + Dimension 2EW (24 oz/ac) + Milestone (7 oz/ac). Treatment 5: CleanTraxx (48 oz/ac) plus Dimension 2EW (24 oz/ac) plus Transline™ (10 oz/ac). Treatment 6: Gallery® SC (31 oz/acre) plus Dimension 2EW (32 oz/acre). This trial showed that pre-emergent herbicides can be an effective way to control stinkwort. Other researchers have also seen effective control with pre-emergent herbicides registered in tree and vine crops (J. Roncoroni, verbal communication).


Gallery SC 31 oz/ac + Dimension 2EW 32 oz/ac+ Accord XRTII 96 oz/ac + MSO 0.5%
Treatment Name | Form Conc | Form Type | Rate Unit
GALLERY SC | 4.17 | SC | 31 fl oz pr/a
DIMENSION 2EW | 2 | EW | 32 fl oz pr/a
ACCORD XRT II | 4 | SL | 96 fl oz pr/a
MSO | | L | 0.5% v/v
CORTEVA
Agriculture Division of DowDuPont™


CleanTraxx 48 oz/ac + Dimension 2EW 24 oz/ac + Milestone 7 oz/ac + Accord XRTII 96 oz/ac + MSO 0.5%
8 months after Treatment:
Treatment Name | Form Conc | Form Type | Rate Unit
CLEANTRAXX | 4.043 | SC | 48 fl oz pr/a
DIMENSION 2EW | 2 | EW | 24 fl oz pr/a
MILESTONE | 2 | SL | 7 fl oz pr/a
ACCORD XRT II | 4 | SL | 96 fl oz pr/a
MSO | | L | 0.5% v/v
CORTEVA
Agriculture Division of DowDuPont™



Acknowledgments

Will Hatler, Field Development Biologist made applications to the stinkwort-infested site provided by Beau Miller, Land Management Specialist for Corteva agriscience. Beau Miller provided photographs of the trial site treatments for the 8 month evaluations.

Joe DiTomaso provided verbal communications on the stinkwort biology and its spread in California.

John Roncoroni provided verbal communications on his experiences controlling stinkwort and information on the aromatics of stinkwort.

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Changing Priorities in Caltrans Roadside Vegetation Management.

William Nantt, Caltrans IVM Manager

Since the inception of Caltrans adoption of the Final Environmental Impact Report (FEIR) in 1992, many things have changed. Among them are political figures, environmental activist priorities, climate change, available vegetation management tools, Caltrans roadside management priorities and available resources. Pesticide use reduction was the goal for many years but due to the scale of catastrophic fires throughout the state, Caltrans pest control advisers are forced into a precarious position between legal forces representing pesticide reduction advocates on one side and fire prevention forces on the other. As old as the FEIR is, it is our guidance and to change it would require years of effort and millions of dollars. Along with following it as closely as possible our most effective tool is forming alliances with industry, academic and governmental entities to interpret the regulations and navigate the legal minefields we encounter in the roadside vegetation management arena.

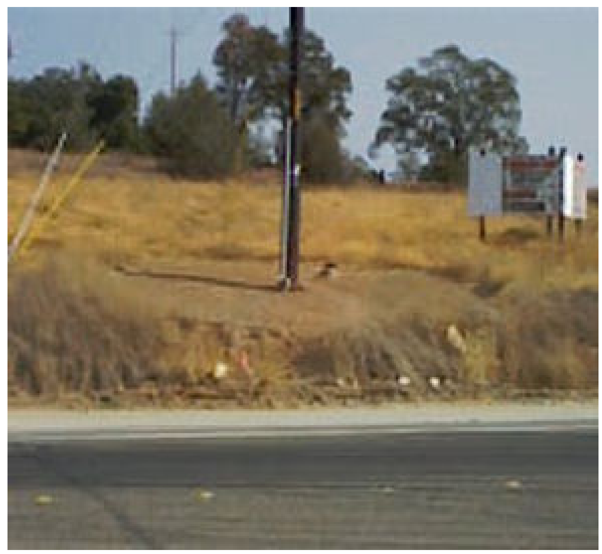
No Math in the Morning: Herbicide Blends for Utility Site Vegetation Management.

Scott A. Johnson sjohnson@wilburellis.com, Vegetation Management Specialist, Wilbur-Ellis Company; Stockton, CA

Use of herbicide blends is increasing in California right of way vegetation management (VM). The benefits of using these blends have logistical, economic, and resistance management benefits for vegetation managers. This presentation will use "Subject Pole" vegetation management programs as an example of using herbicide blends.

Utility power pole vegetation management is required by the California Public Resource Code (PRC). PRC Sections 4292 & 4293 state that utility poles located in State Responsibility Area (SRA — protected by the California Department of Forestry and Fire Protection) with certain hardware are non-exempt or "subject" to the PRC regulations. This hardware includes fuses and switches that can throw sparks or hot metal that could be an ignition sources for fires. These regulations require a 10-foot radius bareground zone and an 8-foot high clear cylinder at base of certain power poles for fire safety. Pole clearing can be manual, mechanical, and/or chemical. An integrated vegetation management program is best, as it combines all appropriate VM methods.

Pole hardware "subject" to PRC 4292-4293



Pole site compliant with PRC 4292

Reasons for these programs include power line maintenance and protection; fuels management and fire safety; and electric service reliability, as well as understanding and support from management and the public.

Subject pole VM program are usually performed by utility contractors under contract to the utility responsible for each service area. Often these contractors are the same companies that mechanically clear under and around distribution (low-voltage) and transmission (high-voltage) powerlines. Since these contractors often make cut surface herbicide applications to the stumps of trees removed near powerlines, they already have Pest Control Business licenses from the California Department of Pesticide Regulation (CDPR), as well as crew supervisors who hold Qualified Applicator Licenses (QAL) or Qualified Applicator Certificates (QAC). Field crew members are members of the International Brotherhood of Electric Workers (IBEW). These applicators all receive the annual pesticide training required by CDPR.

Contractors are assigned groups of poles to clear and treat under work authorizations issued periodically by the utility company. Poles are treated in the fall and winter to receive rainfall to optimize the properties of the pre-emergent herbicides. Prior to the herbicide treatment, the crew will hand-clear a 10-foot radius circle down to bare mineral soil. The most common tool to do this is a "McCloud" firefighting tool. This implement has two heads, one is a pick to remove rock and other similar material. The other head is a large hoe-like end used to rake soil and also to chop any wood in the pole circle. If the pole site is on a slope, the mineral soil is pulled in a berm on the downhill side of the pole to mitigate possible off-site herbicide movement. If tall brush intrudes into the pole area, the crew will also use chainsaws to trim the 8-foot high cylinders required by PRC 4292. At this time crews may apply a chemical pruning herbicide application of triclopyr and/or glyphosate.

Pest Control Adviser recommendations are required for herbicide selection. The basic subject pole program may be written with programmatic recommendations that cover thousands of poles over many counties, but special site-specific recs may be needed in certain cases. These recommendation sites and targets include:

- General bare ground sites *(main emphasis of this presentation)*
- Sensitive sites, e.g., near landscape, crops
- Aquatic - creeks, lakes, culverts, etc.
- Woody plants, e.g., brush, berries, trees

The following is an example of a "foundation" bareground pre-emergent herbicide treatment used by several California utilities:

- 7 oz/ac Esplanade 200 SC (indaziflam)
- 12 oz/ac Portfolio 4F California (sulfentrazone)
- 14 oz/ac Milestone (aminopyralid at spot treatment rate)
- 48 oz/ac Rodeo (glyphosate) for emerged weeds
- 17.25 oz/ac In-Place Deposition Agent (seed oil invert emulsion suspension)
- 8 oz/ac Syl-Tac-EA Surfactant (silicone + ethylated seed oil combination adjuvant)
- Applied in 25 gallons per acre spray volume

This mix has multiple ingredients, some of which are strong grass herbicides, and some which are strong broadleaf herbicides. This mixture gives a bare ground result which complies with PRC 4292.The multiple modes of action provide resistance management and a fire-safe site throughout the entire fire season. The glyphosate controls small weeds that are present. The aminopyralid has both pre-emergent and post-emergent weed activity, especially for certain glyphosate-resistant weeds. Note that the 14-ounce per acre spot treatment rate is allowed by the Milestone label.

While very effective, this chemical mix could cause problems for the contractor. They include:

- Six ingredients in this tank mix can create a challenge to carry all these products into the field.
- Mixing errors are waiting to happen, e.g., did I remember to mix in all the materials at the right rate and in the right order?

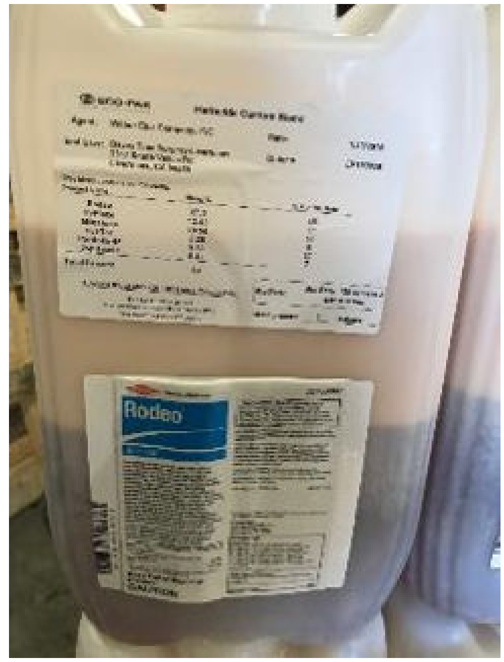
- Handling all the concentrated material could possibly result in increased worker exposure. Mixing and loading is when the most worker exposures occur.
- Production time can be lost daily as crews need to mix each day.
- Increased mix time can mean increased costs. Increased costs lead to lower contractor profits.

Fortunately, custom blending has become a solution to these challenges. A custom blend has all six ingredients in one container. Carrying one container into the field reduces logistical problems. There are no mixing errors because there is no mixing of multiple ingredients. Worker exposure is greatly reduced. Production time increased, which reduce costs. Managed costs can lead to higher contractor profits. As one contractor says, "These herbicide blends work great, but best part is "no math in the morning! My guys don't have to worry about measuring pouring and mixing multiple ingredients. They just shake up the jug, measure and pour in one mix, and go. We save a lot of time starting our days. Saving time means saving money."

Once the contractor, utility, and PCA agree on an appropriate herbicide mix the blend process is straightforward, as follows:

1. The end-user customer (utility contractor, in this case) orders and purchases herbicides and custom blending services from the VM Distributor.
2. The distributor purchases needed herbicides from basic manufacturers. The distributor then places an order on behalf of end-user the blend facility.
3. Basic manufacturers maintain bulk herbicide inventories at the blend facility on consignment.
4. The blender blends and ships product as directed by the distributor.

Each blend container has the EPA labels of each ingredient on the jug or drum, as well as a list of the blend contents (see following pictures). Smaller 5-gallon "cubes" of pre-emergent mixes do require triple rinsing and disposal, but there is less of this because there is only one jug for an entire tank mix. The customer could also clean and re-use some of the cubes as service containers for small jobs where the blend is transferred from large drums.



5-gallon blend cubes with EPA Labels

5-gallon blend cube with ingredients list

Some customers make their first order in 5-gallon cubes, then follow-up blend orders in 15-gallon or 30-gallon drums, then transfer smaller amounts to re-used 5-gallon cubes for field mixing. In this way, triple rinsing is almost eliminated.

5-gallon cube service container

15-gallon and 30-gallon drums

Blends such as these have resistance management benefits. With pre-emergent herbicides, mixing two or three different modes of action reduce the likelihood of developing resistance to problem weeds. The sample blend discussed here has three pre-emergent herbicides (Esplanade 200 SC, Portfolio 4F California, and Milestone); two post-emergent herbicides (glyphosate – Rodeo or Roundup Pro Concentrate – and Milestone – again as a post herbicide), as well as a surfactant (Syl-Tac-EA) and a drift retardant (In-Place).

While most of this presentation has discussed herbicides used in general non-crop sites, there is also the need for a sensitive site herbicide mix to use near landscapes. An example of this is:

- 1 qt/acre Dimension 2 EW (dithiopyr) for grass control
- 31 oz/acre Gallery SC (Isoxaben) for broadleaf weeds
- 48 oz/acre Rodeo (glyphosate) for small emerged weeds
- 32 oz/acre In-Place Deposition-Retention Agent (seed oil invert emulsion suspension)
- 16 oz/acre Syl-Tac-EA Surfactant (silicone + ethylated seed oil combination adjuvant)
- Hi-Light Blue Colorant (if needed)

In summary, custom blending of multiple herbicides and adjuvants has become an effective tool for fire-safe vegetation management in California utility rights of way.

I wish to end with a few comments that I offer in all my presentations. Proper use rates are critical for vegetation management success. Follow label rates for target species, stage of growth, treatment timing, spray volume, and dilution, including adjuvants. Application, Rate, and Timing are critical factors for vegetation management success. The right herbicide, applied properly at the right rate and right time, will achieve the desired vegetation management objective. Remember – there is no substitute for experience. Take time to learn how to do the job right.

Weed Management Programs at Arvin-Edison Water Storage District.

Stephen Smith. Arvin-Edison Water Storage District. 20401 Bear Mountain Road Arvin, CA 93203. ssmith@aewsd.org

For the past 75 years, Arvin Edison Water Storage District (AEWSD) has been tasked with ensuring sustainable, affordable and quality surface and groundwater supplies for the farmers and landowners within the district. The author and his team have been managing weeds, aquatic and terrestrial, along the 47+ miles of canal, 1600 acres of spreading basins, emergency spillways and balancing ponds within AEWSD for the past 26+ years. The author reviewed aerial photographs color-coded for roads and canals that are managed for weed control. Weed management is necessary to prevent the spread of fire, maintain line of sight for safe travel of district vehicles and the general public and to enable quick and accurate review of canal and structural integrity. Rainfall in the district averages 6-inches annually and average high temperatures in the month of July are above 96° F. This presentation focused on terrestrial weed control on canal banks, basins, spillways and balancing ponds.

Starting in 2004, upon hearing reports about weed resistance to glyphosate, the district began using different pre-emergents along some canals to reduce the use of post-emergent products such as glyphosate and gluphosinate. As some canals moved through neighborhoods and/or past sensitive crops such as grapes, the AEWSD team began to utilize pre-emergent herbicides on the tops and outer banks that were labeled for use in sensitive sites such as landscape. For instance, the South Canal was treated in the late fall or winter with Gallery® DF (16 oz/acre) and Dimension® 2EW (32 oz/acre) and obtained excellent control of key weeds, which include Russian thistle (*Salsola spp.*), fleabane (*Conyza bonariensis*), marestail (*Conyza canadensis*) and perennial ryegrass (*Lolium perenne*). All pre-emergent herbicide treatments included Roundup® (96 oz/acre) for control of small broadleaf and grassy weeds. Other canals, such as the Intake Canal were originally treated with a combination of Milestone® (7 oz/acre) and Dimension 2EW (32 oz/acre) and the district was quite satisfied with subsequent weed control. Both of these programs provided good to excellent weed control for the district. In recent years, with new options and formulations, some areas of the Intake Canal are now being treated with Gallery® SC (31 oz/acre) plus Dimension® 2EW (32 oz/acre) plus Cleantraxx® (48 oz/acre). In many areas Clearcast® herbicide (64 oz/acre) is also being used on the inside banks of irrigation canals and controlling many of the aforementioned weeds satisfactorily. For example, the Wasteway a 290 acre facility, is treated entirely with Clearcast tank mixed with either Milestone plus Dimension or Gallery plus Dimension. In other areas, the district has obtained good weed control with mostly Milestone as the pre-emergent herbicide.

Over time pre-emergent herbicide products were being used on virtually all of the AEWSD properties where terrestrial weed control was mandated. One exception to that is the Tejon Spreading Basin, where the district continues to use Roundup only, sprayed 5-6 times per year. Weed control in all areas today is exemplary and the district is often considered one of the most weed-free in the valley. The district has reduced the post-emergent use of glyphosate from over 20 totes annually to just a handful of totes today.

Healthy Schools Act: Tips to Tackle Weeds at Schools. Madiya Nagin, Environmental Scientist, California Department of Pesticide Regulation, 1001 I Street, Sacramento, CA 95814. madiya.nagin@cdpr.ca.gov

This presentation is about integrated pest management techniques that schools can use to manage weeds. According to the Healthy Schools Act, it is the policy of the state that effective least toxic pest management practices should be the preferred method of managing pests at schoolsites. The Department of Pesticide Regulation School and Child Care Integrated Pest Management program provides compliance assistance and pest management training focused on reduced risk pest management methods. New data from the expanded school pesticide use report demonstrates that glyphosate was the most frequently applied active ingredient at schoolsites since 2015. The School and Child Care IPM program is focused on creating resource materials, especially infographics, for schoolsites looking to reduce risks in their vegetation management program. I show examples of these new outreach materials and discuss the pros and cons of some of the strategies outlined.

Organic Herbicide Trials in Yolo and Sacramento Counties. Karey Windbiel-Rojas* and John Roncoroni. University of California Cooperative Extension, Sacramento, Solano, Napa, and Yolo Counties, 2801 Second Street, Davis, CA, 95820. *Corresponding author kwindbiel@ucanr.edu

The desire to find herbicide alternatives for reducing or eliminating application of glyphosate and other synthetic herbicides is on the rise. Landscape pest managers with schools, municipalities, and other organizations are increasingly developing or changing their IPM policies and plans to use organic herbicides for weed control. The general public's concern over glyphosate and other conventional herbicide use in parks, public spaces, schools, and other landscapes is largely the driver for this change.

Few studies have been published that illustrate the efficacy of organic and less toxic postemergence herbicides currently on the market for use in non-agricultural settings. In

California, studies by Wilen in southern California showed that several of the active ingredients in these products resulted in promising weed control.

Our trials were conducted in the winter of 2017/2018 in Woodland, Yolo County, California. The site included 10 treatments with 4 replications each. Applications were made on December 11, 2017 only; plots were not resprayed.

The products applied were acetic acid (WeedPharm), caprylic acid/capric acid (Supress), herbicidal soap (Finalsan), clove oil/cinnamon oil (WeedZap), citric acid/clove oil (Burnout), d-limonene (Avenger Optima), glyphosate (RoundUp), and an untreated control. Except for glyphosate, all these products have contact-type activity and do not translocate to the roots of treated plants. Thorough spray coverage is needed, and none of these products have residual activity.

While our treatments did not yield definitive results, we observed some initial burn-down activity from several of these products, but after a couple of weeks, the weeds began to regrow (except for glyphosate). This study was preliminary only, with the timing of application not being ideal. We were aware that the materials being tested might not be effective in controlling weeds in cold and cloudy conditions, but landscape managers are using these products during winter conditions, so conducting trials at this time was not without practical implications. We plan to conduct additional trials using the products above and plus several others at different times of the year in different temperatures and conditions.

Planting Timing, Seeding Rate and Mowing Height of Tall Fescue into Zoysiagrass.

Scott Steinmaus, PhD, Horticulture and Crop Science Department, California Polytechnic State University San Luis Obispo, ssteinma@calpoly.edu

There is ample documentation that well established turf can be effectively managed without herbicides (Busey 2003). Planting at higher densities contributes to rapid establishment, which resists weed colonization. Weed encroachment is generally lower in turfgrass mixtures because of rapid development of foliage cover. Generally, higher mowing heights (e.g. 3 inches) resist weeds better than lower heights, however, most fairways on golf course mow at about 0.5 inches. A golf course manager's primary objective is to provide high quality playing surface, year-round that requires minimal maintenance. This includes thorough foliage cover and green color throughout the year. To meet this end, our objectives were to determine the seeding rate for a cool season C3 grass, tall fescue (*Festuca arundinacea*) into a warm season C4 turf, zoysiagrass (*Zoysia japonica)* that develops rapidly, tolerates drought, and maintains green color in mixture throughout the year. The recommended planting date for tall fescue is in the Fall, however, it may suffer from competition if it is sown later into established zoysiagrass. Therefore, we assessed the effect of an earlier planting date (i.e. at the same time of zoysia planting) compared with the standard Fall planting. A secondary objective was to determine if a 0.5" mowing height of a tall fescue/zoysiagrass mixture provides acceptable playing surfaces, as this height is standard on golf course fairways.

Zoysiagrass was established July 2015 (at 1lb/1000ft^2) over the entire experimental area, and then a three factor factorial completely randomized split plot design was overlaid on this area with the following 3 factors: mowing heights (main plot) at 2 levels (3" and 0.5"), tall fescue (TF) planting dates (subplot) at 2 levels (same time of Zoysia planting (Summer 2015) and autumn (Fall 2015)), and tall fescue tall fescue seeding rates (subplot) at 3 levels (2, 4, or 8 lbs per 1000 ft^2). Cultural practices such as irrigation and fertilizer application were according to standard practices for the central coast California golf course industry. Weekly ratings of percent cover (1-100%) and quality (1-10(best)) were made during the summer 2015 through winter 2017. Repeated measures (within subject effect=time) as a split plot (between subject effects: mow ht=mainplot, TF seed rate and timing=subplots) using proc glm manova and polynomial contrasts at 5% level in SAS (ver 9.4).

The most dominant effect of the experiment was the rapid development of cover and quality of the plots where tall fescue was planted at the same time as the zoysia grass compared to the Fall planting of fescue ($p<0.0001$). Tall fescue planted at the same time as zoysia attained >90% cover in mixture within 6 weeks of planting compared to 12 weeks for the Fall planted fescue. It took almost a year for the Fall planted fescue to reach a high quality (8.0) in mixture. There were many other nuanced effects that fluctuated so as to not reveal any consistent pattern. For example, there was a significant ($p<0.0047$) mowing height by planting date interaction whereby the 0.5" mowing height had higher cover than the 3" height but only for the Fall-planted and not the summer-planted fescue. Ultimately, the 0.5" mowing height would provide acceptable turf cover and quality for this mixture. There was a significant tall fescue seeding rate effect on cover and quality ($p<0.0043$ and 0.0002, respectively) where the 8lb/1000ft^2 rate was significantly higher than the other rates in the beginning of the experiment but eventually there were no differences among rates by winter 2016 (12 weeks).

Conclusions:

- Tall fescue planted in summer at the same time as zoysiagrass filled in much sooner than when planted at the recommended time (Fall).
- There were no consistent differences in cover or quality associated with mowing height so 0.5" should be is sufficient for fairways.
- Faster development for higher seeding rates but only at the very beginning.

Pylex (topramezone: BAS670) for Postemergent Control of English Daisy *(Bellis perennis)* and Kikuyugrass *(Pennisetum clandestinum).* Mark Mahady, President, Mark M. Mahady & Associates, Inc., P.O. Box 1290, Carmel Valley, CA 93924, (831) 236-2929, markmahady@aol.com

Introduction

English lawn daisy (*Bellis perennis*) and kikuyugrass (*Pennisetum clandestinum*) are two of the most troublesome and difficult to control turfgrass weeds in California.

The objective of this field study was to compare the activity of Pylex (BAS670: topramezone) alone and in tank mix combinations with Drive XLR8 (quinclorac) or Turflon Ester Ultra (triclopyr) for postemergent control of English daisy and suppression of kikuyugrass in a mixed stand of cool season grasses maintained as fairways conditions.

Materials & Methods

This replicated field trial was conducted in full sun conditions in a fairway area on the 7th hole at Laguna Seca Golf Ranch located in Monterey, California. This site has showed a significant history of English daisy pressure with invading kikuyugrass. Primary turf types included annual bluegrass (*Poa annua*), perennial ryegrass and creeping bentgrass with a slight infestation of kikuyugrass.

The plot was mowed three times per week at a cutting height of 0.5 inches, received moderate fertility and was irrigated to avoid moisture stress. This coastal area is characterized as a Mediterranean climate with occasional early morning summer fog. During the summer, daytime high temperatures generally range from 65 to 78 degrees F. with nighttime low temperatures of 48 to 58 degrees F.

Percent English daisy cover was evaluated on September 21, 2012 to establish weed pressure across the entire plot prior to the first application. The average English daisy cover for all treatments at the start of the field trial was 30.6%. Treatments were replicated four times and randomized to equalize existing English daisy pressure across all treatments.

Treatments as presented in Table 1 were deployed as two sequential applications at 21-day intervals. On September 21, 2012, the day of the first treatment deployment, soil temperature registered 62.8° F at a depth of three inches and the air temperature was 60.1° F at 9:14 am.

Products reviewed included the following:

- Pylex — BAS670: topramezone (BASF)
- Drive XLR8 — quinclorac (BASF)
- Turflon Ester Ultra — triclopyr (Corteva Agriscience)
- Sapphire — penoxsulam (Corteva Agriscience)
- MSO — methylated seed oil
- Activator 90 — non-ionic surfactant

Individual treatment plots measured 5' x 10' with two-foot aisle ways. Treatments were replicated four times.

A calibrated CO_2 propelled spray system pressurized to 28 psi and equipped with four 11004LP Tee-Jet nozzles applied liquid treatments at a spray volume of 65 gallons per acre or 1.5 gallons per thousand square feet (1000 ft^2 or M). A pacing watch was used for all spray applications to ensure the uniform and accurate delivery of all treatments.

Field plots were evaluated for turf color, turf injury, turf quality, percent weed cover, weed injury and calculated weed control. Turf color was rated on a 0 to 10 scale with zero representing no color, 6 minimally acceptable color and 10 the darkest green color possible. Turf injury was rated on a 0 to 100 scale with zero representing no injury, 30 the maximum degree of acceptable injury with good potential for recovery and 100 dead turf. Turf quality was rated on a 0 to 10 scale with zero representing no quality, 6 minimally acceptable quality and 10 the best quality. Weed injury was rated on a 0 to 100 scale with zero representing no herbicide symptoms, 30 minimally acceptable epinasty and 100 weed death.

Calculated weed control was determined by rating percent weed cover on the final rating date and comparing percent English daisy cover in treatment plots to that in the untreated check plot. Data were summarized and statistically analyzed. Differences between means were determined via LSD.

Table 1. Treatment and application schedule. Pylex (BAS670: topramezone) for postemergent control of English daisy and kikuyugrass. Laguna Seca Golf Ranch, Monterey, California, 2012. Mark M. Mahady & Associates, Inc.

	Treatments	Rate	Application Schedule
1)	Untreated Check	*	*
2)	Drive XLR8 + Pylex + MSO	64 fl oz/A + 1 fl oz/A + 1 % v/v	2x: 9/21/12 & 10/12/12
3)	Pylex + MSO	1 fl oz/A + 1 % v/v	2x: 9/21/12 & 10/12/12
4)	Pylex + Turflon Ester Ultra + MSO	1 fl oz/A + 32 fl oz/A + 1 % v/v	2x: 9/21/12 & 10/12/12
5)	Sapphire + Activator 90	8 fl oz/A + 0.25% v/v	2x: 9/21/12 & 10/12/12

Key Results

◆ *Pylex and Cool Season Grass Injury (Table 2)*

- Single and sequential applications of Treatment 4 Pylex + Turflon + MSO resulted in unacceptable levels of turfgrass injury 14 DAA1, 21, DAA1, 14 DAA2, 21 DAA2 and 42 DAA2 (Table 2). Differences were statistically significant when compared to the untreated check.
- Sequential applications of Treatment 3 Pylex + MSO resulted in marginally acceptable turfgrass injury 14 DAA2 and 21 DAA2. Differences were statistically significant when compared to the untreated check.
- Sequential applications of Treatment 2 Drive + Pylex + MSO showed marginally acceptable turfgrass injury 21 DAA2. Differences were statistically significant when compared to the untreated check.
- Treatment 5 Sapphire + NIS, the industry standard for English daisy control, showed marginally acceptable turfgrass injury 14 DAA2 and 21 DAA2. Differences were statistically significant when compared to the untreated check.
- From a practical agronomic standpoint, Treatment 4 Pylex + Turflon + MSO, exhibited excessive and unacceptable injury on cool season grasses maintained as fairway turf.

Table 2. Injury to a cool season grass (CSG) mixture consisting of annual bluegrass, perennial ryegrass and creeping bentgrass following single and sequential applications of Pylex. Laguna Seca Golf Ranch. Monterey, CA. 2012. Mahady & Assoc, Inc.

Treatments	Rate	CSG Injury[1] 9/21/12 DOA1	CSG Injury 10/5/12 14 DAA1	CSG Injury 10/12/12 DOA2	CSG Injury 10/26/12 14 DAA2	CSG Injury 11/2/12 21 DAA2	CSG Injury 11/23/12 42 DAA2
1 Untreated Check	*	0.0 a[3]	0.0 b	0.0 b	0.0 d	0.0 c	0.0 b
2 Drive+Pylex+MSO	64 oz/A+1 oz/A+1% v/v	0.0 a	1.3 b	2.5 b	7.5 cd	**21.0 b**	10.0 b
3 Pylex+MSO	1 oz/A+1% v/v	0.0 a	3.8 b	0.0 b	**26.3 b**	**24.3 b**	8.8 b
4 Pylex+Turflon+MSO	1 oz/A+32 oz/A+1% v/v	0.0 a	**43.5 a**[2]	**44.3 a**	**69.0 a**	**75.5 a**	**62.5 a**
5 Sapphire+NIS	8 oz/A+0.25% v/v	0.0 a	6.8 b	6.3 b	**17.5 bc**	**18.5 b**	11.3 b
LSD (P=.05)		0.00	8.07	9.19	12.15	12.51	13.33
Standard Deviation		0.00	5.24	5.96	7.89	8.12	8.65
CV		0.00	47.39	56.27	32.79	29.16	46.75

[1] Injury was rated on a 0-100 scale with 0 representing no injury, 30 a maximum level of acceptable injury, and 100 dead turf.
[2] **Red highlights** denote the greatest turfgrass injury.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

◆ *Pylex and Kikuyugrass Injury (Tables 3 and 4)*

- The primary turf types present across the field plot included annual bluegrass, perennial ryegrass and creeping bentgrass. However, there were patches of kikuyugrass present and treatment effects were observed and data generated.
- Sequential applications of Treatment 5 Sapphire + NIS did not result in kikuyugrass injury during any evaluation date over the course of the 72-day trial.

- Single and sequential applications of Treatment 2 (Drive + Pylex + MSO), Treatment 3 (Pylex + MSO), and Treatment 4 (Pylex + Turflon + MSO), resulted in significant kikuyugrass injury 14 DAA1, 21 DAA1, 14 DAA2, 21 DAA2 and 42 DAA2 (Table 3). Differences were statistically significant when compared to the check.
- Pylex exhibited good activity on kikuyugrass. Tank mixing Turflon Ester Ultra with Pylex appeared to enhance kikuyugrass injury.

Table 3. Injury to kikuyugrass following single and sequential applications of Pylex. Laguna Seca Golf Ranch. Monterey, CA. 2012. Mark M. Mahady & Associates, Inc.

Treatments	Rate	KKU Injury[1] 10/5/12 14 DAA1	KKU Injury 10/12/12 21 DAA1	KKU Injury 10/26/12 14 DAA2	KKU Injury 11/2/12 21 DAA2	KKU Injury 11/23/12 42 DAA2
1 Untreated Check	*	0.0 c[3]	0.0 c	0.0 b	0.0 c	0.0 b
2 Drive+Pylex+MSO	64 oz/A+1 oz/A+1% v/v	58.8 a	**74.3 a**	**89.0 a**	**91.0 b**	**93.3 a**
3 Pylex+MSO	1 oz/A+1% v/v	48.3 b	54.3 b	**86.3 a**	**91.3 b**	**91.3 a**
4 Pylex+Turflon+MSO	1 oz/A+32 oz/A+1% v/v	60.8 a	**76.3 a**[2]	**91.0 a**	**96.8 a**	**97.0 a**
5 Sapphire+NIS	8 oz/A+0.25% v/v	0.0 c	0.0 c	0.0 b	0.0 c	**0.0 b**
LSD (P=.05)		8.89	2.27	4.13	2.33	5.70
Standard Deviation		5.77	1.47	2.68	1.51	3.70
CV		17.2	3.60	5.03	2.71	6.58

[1] Injury was rated on a 0-100 scale with 0 representing no injury, 30 a maximum level of acceptable injury, and 100 dead turf.
[2] **Red highlights** denote the greatest kikuyugrass injury.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

- Pylex applications also resulted in whitening or bleaching of susceptible plant material. Single and sequential applications of Treatment 3 (Pylex + MSO) resulted in highly noticeable whitening of kikuyugrass 14 DAA1, 21 DAA1 and 14 DAA2. Differences were statistically significant when compared to the check.
- The addition of Drive as a tank mix component (Treatment 2 Drive + Pylex + MSO) or Turflon Ester Ultra (Treatment 4 Pylex + Turflon + MSO) virtually eliminated the bleaching effect observed with Pylex alone.

Table 4. Whitening of kikuyugrass following single and sequential applications of Pylex. Laguna Seca Golf Ranch. Monterey, CA. 2012. Mark M. Mahady & Associates, Inc.

Treatments	Rate	KKU White[1] 10/5/12 14 DAA1	KKU White 10/12/12 21 DAA1	KKU White 10/26/12 14 DAA2	KKU White 11/2/12 21 DAA2	KKU White 11/23/12 42 DAA2
1 Untreated Check	*	0.0 b[3]	0.0 b	0.0 b	0.0 a	0.0 a
2 Drive+Pylex+MSO	64 oz/A+1 oz/A+1% v/v	0.0 b	0.0 b	0.0 b	2.5 a	0.0 a
3 Pylex+MSO	1 oz/A+1% v/v	**60.0 a**[2]	**36.3 a**	**66.3 a**	3.8 a	0.0 a
4 Pylex+Turflon+MSO	1 oz/A+32 oz/A+1% v/v	0.0 b	0.0 b	0.0 b	5.0 a	0.0 a
5 Sapphire+NIS	8 oz/A+0.25% v/v	0.0 b	0.0 b	0.0 b	0.0 a	0.0 a
LSD (P=.05)		0.00	3.30	3.30	5.45	0.00
Standard Deviation		0.00	2.14	2.14	3.54	0.00
CV		0.00	29.53	16.16	157.13	0.00

[1] Rated on a 0-100 scale with 0 representing no effects, 30 a maximum level of acceptable whitening and 100 completely white turf.
[2] **Red highlights** denote the most visible whitening to kikuyugrass plants.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

◆ ***Pylex and Turfgrass Quality (Table 5)***

- Cool season grass turfgrass quality trends followed turfgrass injury trends.

- Single and sequential applications of Treatment 4 Pylex + Turflon + MSO resulted in unacceptable CSG quality 14 DAA1, 21 DAA1, 14 DAA2, 21 DAA2 and 42 DAA2 (Table 5). Turflon tank mixed with Pylex injured *Poa annua* and reduced overall turf quality. Differences were statistically significant when compared to the untreated check.

- Sequential applications of Treatment 3 Pylex + MSO resulted in marginally acceptable turfgrass quality during all six rating events over the course of the 72-day trial.

- Sequential applications of Treatment 2 Drive + Pylex + MSO showed higher turf quality ratings through the trial than Treatment 3 Pylex + MSO. The addition of Drive XLR8 as a tank mix component to Pylex+ MSO appeared to enhance the safety margin on cool season grasses and slightly improve overall turf quality.

- Sequential applications of Sapphire at the 8 oz/A rate did result in a slight reduction in turf quality over the course of the trial. This effect is often observed in the field with late summer and fall applications of Sapphire at the 8 oz/A rate. Spring applications of Sapphire generally exhibit better turfgrass safety.

Table 5. Quality of a cool season grass (CSG) mixture consisting of annual bluegrass, perennial ryegrass and creeping bentgrass following single and sequential applications of Pylex. Laguna Seca Golf Ranch. Monterey, CA. 2012. Mahady & Assoc, Inc.

Treatments	**Rate**	**CSG Quality[1] 9/21/12 DOA1**	**CSG Quality 10/5/12 14 DAA1**	**CSG Quality 10/12/12 DOA2**	**CSG Quality 10/26/12 14 DAA2**	**CSG Quality 11/2/12 21 DAA2**	**CSG Quality 11/23/12 42 DAA2**
1 Untreated Check	*	4.0 a[3]	4.0 a	4.0 a	4.0 ab	4.0 a	3.8 a
2 Drive+Pylex+MSO	64 oz/A+1 oz/A+1% v/v	3.8 a	3.8 a	3.8 a	4.5 a	4.3 a	4.3 a
3 Pylex+MSO	1 oz/A+1% v/v	3.3 a	3.3 ab	3.3 ab	**3.3 b**	3.8 a	3.8 a
4 Pylex+Turflon+MSO	1 oz/A+32 oz/A+1% v/v	3.5 a	**2.5 b**[2]	**2.5 b**	**2.0 c**	**2.3 b**	**2.5 b**
5 Sapphire+NIS	8 oz/A+0.25% v/v	3.5 a	3.3 ab	3.3 ab	3.5 b	3.5 a	4.3 a
LSD (P=.05)		0.67	0.73	0.73	0.72	0.73	0.99
Standard Deviation		0.44	0.47	0.47	0.47	0.47	0.65
CV		12.16	14.16	14.16	13.49	13.36	17.45

[1] Quality rated on a 0-10 scale with 0 representing no quality, 6 acceptable quality and 10 the best possible quality.
[2] **Red highlights** denote the greatest reduction in turfgrass quality.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

◆ ***English Daisy Percent Control (Table 6)***

Treatment by treatment observations describing English daisy percent control are presented as follows.**Treatment 1:** The untreated check plot contained an average of 30.25% English daisy cover on 11/23/12. English daisy plants were robust.

1. **Treatment 2:** Two sequential treatments of a tank mixture containing Drive XLR8 (64.0 oz/A) + Pylex (1 oz/A) + MSO (1% v/v) exhibited very good English daisy control (94.4%) 42 DAA2. Minor English daisy escapes in treatment plots were observed. In terms of overall performance the Drive + Pylex + MSO exhibits faster burndown than Sapphire the industry standard, but Sapphire exhibited a slightly higher level of control (99.3%).
2. **Treatment 3:** Two sequential treatments of a tank mixture containing Pylex (1 oz/A) + MSO (1% v/v) exhibited marginally acceptable English daisy control (85.1%) 42 DAA2.
3. **Treatment 4:** Two sequential treatments of a tank mixture containing Pylex (1 oz/A) + Turflon Ester Ultra (32 oz/A) + MSO (1% v/v) exhibited very good English daisy control (94.4%) 42 DAA2. Unfortunately, this tank mixture exhibited unacceptable injury to the cool season grasses present in the trial. Pylex + Turflon + MSO exhibited faster burndown than Sapphire, the industry standard, but Sapphire exhibited a slightly higher level of control (99.3%).
4. **Treatment 5:** Two sequential treatments of a tank mixture containing Sapphire (8 oz/A) + NIS (0.25% v/v) exhibited excellent English daisy control (99.5%) 42 DAA2. Sapphire treated plots exhibited slower English daisy burndown, collapse and dissipation than plots treated with Pylex, but over time the level of control actually exceeded Pylex alone and Pylex tank mix combinations. English daisy regrowth has been an issue with Sapphire. There have also been some turf safety issues with Sapphire at the 8 oz/A rate, particularly with late summer/fall applications, so today the general recommendation is two to three applications in the spring at 4 oz/A.

Table 6. English daisy (ED) percent cover and (percent control) following single and sequential applications of Pylex. Laguna Seca Golf Ranch. Monterey, CA. 2012. Mark M. Mahady & Associates, Inc.

Treatments	% Cover Rate	ED % Cover ***** 9/21/12 DOA1	ED % Cover (%Control)[1] 10/12/12 21 DAA1	ED % Cover (%Control) 10/26/12 14 DAA2	ED % Cover (%Control) 11/2/12 21 DAA2	ED (%Control) 11/23/12 42 DAA2
1 Untreated Check	*	29.5 a[3] (***)	29.8 a (0.0%)	30.3 a (0.0%)	31.0 a (0.0%)	32.250 a (0.0%)
2 Drive+Pylex+MSO	64 oz/A+1 oz/A+1% v/v	30.8 a (***)	25.0 a (16.0%)[1]	3.8 bc (87.6%)	2.8 b **(91.1%)**	1.813 b **(94.4%)**
3 Pylex+MSO	1 oz/A+1% v/v	30.3 a[2] (***)	28.5 a (4.2%)	5.8 bc (81.0%)	2.3 b **(92.7%)**	4.813 b (85.1%)
4 Pylex+Turflon+MSO	1 oz/A+32 oz/A+1% v/v	32.5 a (***)	23.8 a (20.2%)	1.5 c **(95.0%)**	1.8 b **(94.4%)**	1.813 b **(94.4%)**
5 Sapphire+NIS	8 oz/A+0.25% v/v	29.8 a (***)	28.8 a (3.4%)	7.5 b (75.2%)	3.0 b **(90.3%)**	0.150 b **(99.5%)**
LSD (P=.05)		19.49	19.34	4.22	2.11	4.222
Standard Deviation		12.65	12.55	2.74	1.37	2.740
CV		41.40	46.22	28.1	16.8	33.55

[1] English daisy control calculated versus the percent cover of the untreated check plot.
[2] **Red highlights** denote the highest levels of English daisy control.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

Key Take Home Messages

1. Pylex (1 oz/A) exhibited good activity on kikuyugrass and exhibited a white, bleaching discoloration on kikuyugrass following one application.

2. Adding Drive XLR8 or Turflon Ester Ultra to Pylex dynamically reduced the bleaching effect on kikuyugrass.

3. Adding Turflon to Pylex dynamically increased *Poa annua* injury.

4. Drive XLR8 (64.0 oz/A) + Pylex (1 oz/A) + MSO (1% v/v) exhibited very good English daisy control (94.4%) 42 DAA2. In terms of overall performance the Drive + Pylex + MSO exhibited faster burndown than Sapphire the industry standard, but Sapphire exhibited a slightly higher level of control (99.3%).

5. Two sequential treatments of a tank mixture containing Pylex (1 oz/A) + MSO (1% v/v) exhibited marginally acceptable English daisy control (85.1%) 42 DAA2.

6. Two sequential treatments of a tank mixture containing Pylex (1 oz/A) + Turflon Ester Ultra (32 oz/A) + MSO (1% v/v) exhibited very good English daisy control (94.4%) 42 DAA2. Unfortunately, this tank mixture exhibited unacceptable injury to the cool season grasses present in the trial. Pylex + Turflon + MSO exhibited faster burndown than Sapphire the industry standard, but Sapphire exhibited a slightly higher level of control (99.3%).

7. Two sequential treatments of a tank mixture containing the industry standard for English daisy control, Sapphire (8 oz/A) + NIS (0.25% v/v), exhibited excellent English daisy control (99.5%) 42 DAA2. Sapphire treated plots exhibited slower English daisy burndown, collapse and dissipation than plots treated with Pylex, but over time the level of control actually exceeded Pylex alone and Pylex tank mix combinations.

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See & Spray for Weed Control in Agronomic Crops. William L. Patzoldt*. Blue River Technology, Sunnyvale, CA, USA. *Corresponding author (william.patzoldt@bluerivert.com)

Deep learning is an emerging subfield of artificial intelligence that allows computers to teach themselves how to solve problems. Deep learning has especially been useful in the identification of objects from pictures, whether the objects are people, cars, or plants. Research has demonstrated that deep learning technology can identify plants from images, and further separate plants into pre-determined categories (e.g., crops or weeds). The process of teaching computers to identify and differentiate plants is similar to teaching humans, which involves creating test sets of plants with correct labels for the purpose of training. Students (or computers) learn how to associate combinations of specific plant features with the correct answer. Once humans and computers have identified and learned how to associate feature combinations with specific plants, it becomes easier to remember how to identify the plants in future settings. Once trained, a human or computer can remember, or recall, correct plant identification almost instantaneously. In agriculture, the ability to identify and differentiate plants creates the opportunity for management at the plant level. Specifically, the identification of crops and weeds allows the application of herbicides to weeds and not crops, which is the current emphasis of See & Spray™ technology. The application of herbicides to only weeds has the potential to reduce herbicide input costs, facilitate more aggressive adjuvant combinations, or allow for cost effective resistance management programs containing multiple site-of-action chemistries. Beyond herbicides, the ability to target crops opens the door for more efficient applications of fungicides, insecticides, biologicals, or plant nutrients.

Weed Management in Dry Bean Production in California. Rachael Long, UC Cooperative Extension Farm Advisor, Yolo County, rflong@ucanr.edu

There are four species and eight market classes of dry beans grown in California. These include common beans (kidney, pink, white, cranberry, black turtle, *Phaseolus vulgaris*), lima beans (baby and large, *P. lunatus*), blackeye beans (cowpea, *Vigna unguiculata)*, and garbanzo beans (chickpea, *Cicer arietinum)*. Dry beans are an important specialty crop in California, with growers harvesting 50,000 acres of dry beans valued at $60 million in 2017. Lima beans accounted for 50% of the acreage, with California producing nearly 99% of the U.S. domestic supply of dry limas. Garbanzo beans accounted for 20% of the acreage, primarily for the canning or dry packaged markets. Blackeyes were 22% of the total acreage, and the rest were common beans, with kidneys primarily going for the canning and dry packaged industry.

Weeds are a challenge for dry bean producers, as they can reduce bean yield and quality and interfere with harvesting practices if left uncontrolled. These includes some tough to manage weeds such as summer annuals like nightshade (hairy and black, *Solanum spp.*) and groundcherry *(Physalis spp.)* that can severely stain and reduce bean quality at harvest, as well as barnyardgrass *(Echinochloa crus-galli)*. Difficult to control perennial species include nutsedge *(Cyperus spp.)*, Johnsongrass *(Sorghum halepense)*, field bindweed *(Convolvulus arvensis)*, and bermudagrass *(Cynodon dactylon)*. The best way to manage weeds in dry bean production is through crop rotation, good agronomic practices (e.g. proper seedbed preparation and appropriate irrigation and fertility management), the use of herbicides, and cultivating dry beans prior to row closure.

A standard weed control program for dry beans (especially common, lima,and blackeyes) includes the use of pre-emergent herbicides mechanically incorporated into beds prior to planting. Table 1 shows a list of registered pre-plant herbicides for the different bean species, including common beans, limas, blackeyes, and garbanzos. Each specific bean species has a specific pesticide label defining use (that is, herbicide registration depends on the bean type). It is important to read the pesticide label carefully (as required by law) to make sure that the specific herbicide being used is registered for that specific bean crop.

Garbanzos have a long growing season, requiring both winter and summer weed control for best yields and quality. A standard weed control practice for garbanzos includes planting the beans, then applying herbicides over the beds before crop and weed emergence. Herbicides are activated by a half-inch of rainfall or sprinkler irrigation (Table 2). Growers often use Chateau and Goal for good, broad-spectrum weed control (applied within 2-days after planting), though Goal can injure the bean crop. However, garbanzos plants will recover from injury from Goal, with no impacts on yield or bean quality at harvest. Our UCCE dry bean program is currently focusing on managing broadleaf weeds in garbanzos and blackeyes, as the efficacy of the pre-emergence herbicides decreases over time and there are limited options for post emergence weed control in these crops.

Weed control post- plant post- emergence is challenging because there are few broadleaf herbicides for controlling weeds in established dry bean fields for all bean species (Table 3). BASF brought back a label for Basagran last year for common beans and limas in California. However, plant injury can still occur, so it is imperative that the bean stand is healthy before using this herbicide to make sure the plants quickly recover and grow out of the injury, or yield losses will occur. Hooded and/or directed sprays are also available for other broadleaf herbicides, including Shark and Sandea (do not apply on the crop or phytotoxicity will occur). Grass weeds can be readily controlled with Poast or SelectMax.

More information on managing weeds in dry beans can be found in the UC IPM Guidelines for Weed Management in Dry Beans, http://ipm.ucanr.edu/, as well as the UC ANR production manuals for dry beans including, Common bean (8402), Garbanzos (8634), Limas (8505), and Blackeyes (21518) https://anrcatalog.ucanr.edu/Items.aspx?hierId=1100.

Table 1. Herbicides labeled for weed control- preplant, mechanically incorporated, by dry bean class.

✓= registered label use	**Common bean kidney, pink, etc.**	**Lima, baby, large**	**Blackeye cowpea**	**Garbanzo chickpea**
Preplant - mechanically incorporated				
EPTC (Eptam 7E)	✓			
ethalfluralin (Sonalan)	✓	✓	✓	
pendimethalin (Prowl H2O)	✓	✓	✓	✓
s-metolachlor (Dual Magnum)	✓	✓	✓	✓
trifluralin (Treflan)	✓	✓	✓	✓
metribuzin (Metribuzin)				✓

Table 2. Herbicides labeled for weed control after planting but before crop and weed emergence by dry bean class.

✓ = registered label use	**Common bean kidney, pink, etc.**	**Lima, baby, large**	**Blackeye cowpea**	**Garbanzo chickpea**
After planting - before crop and weed emergence				
flumioxazin (Chateau SW)	✓	✓	✓	✓
metribuzin (Metribuzin)				✓
oxyfluorfen (Goal)				✓

Table 3. Herbicides labeled for weed control after planting, after crop and weed emergence by dry bean class.

✓= registered label use	**Common bean kidney, pink, etc.**	**Lima, baby, large**	**Blackeye cowpea**	**Garbanzo chickpea**
After planting - after crop and weed emergence				
bentazon (Basagran)	✓	✓		
carfentrazone (Shark EW)*	✓	✓	✓	✓
halosulfuron (Sandea)*	✓	✓	✓	✓
clethodim (Select Max)	✓	✓	✓	✓
sethoxydim (Poast)	✓	✓	✓	✓
fluazifop (Fusilade DX)	✓	✓		✓

*Hooded and/or directed sprays only, row middles (do not apply to the crop or injury will occur)

Impact of Field Edge Habitat on Weed Control in Adjacent Crops. Rachael Long, UC Cooperative Extension Farm Advisor Yolo Co., CA, Kelly Garbach, Senior Ecologist, Point Blue, California

Field margins that define crop boundaries in California are an integral part of farmlands and serve multiple functions. This includes field access for farm equipment (e.g. tractors), conveyance areas for irrigation source water and tail-water runoff, areas for storing crops (e.g. hay), and equipment needs (e.g. wells and subsurface drip systems). To maintain their function, field edges are intensively managed, primarily by mowing, herbicides, and disking. Burning used to be more frequent, but has decreased due to increased air quality regulations in our state (Garbach and Long 2017).

The most frequently used herbicides for controlling weeds on field margins is glyphosate (e.g. Roundup) followed by oxyfluorfen (Goal), and glufosinate (Rekon) (2016 CA DPR pesticide use database). Although effective, use of herbicides, along with disking, mowing, and burning field edges has led to a loss of habitat and a decline in biodiversity on farms, including negative impacts to native bees and natural enemies of crop pests. This results in a loss of ecosystem services (e.g. pollination and natural pest control services) leading to more reliance on external inputs (e.g. honey bee hives and pesticides) to ensure high crop productivity (Long et al. 2017).

To bring biodiversity back to farmlands, some growers are planting habitat on field edges in areas that cannot be farmed. This includes along terraces left over from land leveling, old fence lines, under powerlines, or creeks and drainage areas, so no land is taken out of production. Benefits of field edge habitat with flowering shrubs includes increased native bees and natural enemies on farms for better pollination and pest control in adjacent crops (Morandin et al. 2016). Despite these benefits, resources, and support for conservation programs through USDA funded programs, field edge habitat restoration on farms remains low. This lack of adoption of restoration practices is explained in part by landholders' concerns about habitat plantings, including increased presence of weeds, rodents, and insect pests (Garbach and Long 2017).

To better understand weed concerns in field edges, we conducted a weed survey on field margins on farms with and without hedgerows, in the Sacramento Valley from 2015 to 2017. This included edges that were managed conventionally (mowing, disking, herbicides) as well as edges that were planted with California native flowering shrubs, including coffeeberry, Toyon, California lilac and buckwheat, and elderberry. We conducted point and quadrat surveys for weed abundance and diversity on field edges, crop edges, and in the crop, field and row crops (e.g. tomatoes, wheat) as well as orchards (e.g. walnuts and almonds), during the spring and summer time to assess for winter and summer weed abundance and diversity.

Preliminary data show that field edges planted with hedgerows had a lower abundance and diversity of weeds compared to conventionally managed field edges. For winter weeds, the hedgerows had about 40 percent fewer weed species compared to the conventional sites. For summer weeds, the hedgerows had about 30 percent fewer weed species compared to the conventional sites. Percent weed cover was lower in the hedgerows for both summer and winter weeds, compared to the conventionally managed sites. Overall, weeds need to be managed on farms regardless of field edge habitat, but once hedgerows are established, the plants can help suppress weeds.

Establishment of habitat on field crop edges requires preparing the site by disking, solarization, or the use of herbicides for weed control. Site preparation is followed by planting the shrubs in the fall or winter, before hot, dry summers set in. Irrigation is generally needed for the first 5-years of establishment (native California perennial shrubs are slow to establish). Weed control during this establishment phase is critical to ensure minimal weed competition until the native shrubs become large enough to shade out weeds. Information on plant selection and establishing hedgerows and other habitat on farms in California (e.g. wildflowers) can be found on the Xerces Society website, Long and Anderson 2010, and Gornish 2017.

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Why We Should be Concerned about the Dioecious Amaranths.

Lynn M. Sosnoskie, Agronomy and Weed Science Advisor, Merced and Madera Counties, lmsosnoskie@ucanr.edu, 209.385.7403

According to the CalFlora website (http://www.calflora.org/), 21 species of amaranths (often called pigweeds) in California. While many are non-native, a few, including prostrate pigweed (*Amaranthus blitoides*) and Palmer amaranth (*Amaranthus palmeri*), are indigenous. While it may be convenient to lump all of the pigweeds together when considering weed management options, proper identification is important for understanding the potential for crop yield loss (e.g. not all amaranths were created equal with respect to size and competitiveness) and the possibility of herbicide resistance (e.g. populations of Palmer amaranth with resistance to glyphosate have been confirmed in the state) impacting management efficacy.

Palmer amaranth and waterhemp (*Amaranthus rudis*) are two species of current interest in the Central Valley. Palmer amaranth is an erect pigweed species (growing to heights >6-8 feet) that is native to the Southwestern deserts of the US. The stems are hairless and range from green to red in color. Leaf shape can be variable, but most leaves are egg-, diamond-, or lance-shaped; leaves may sometimes exhibit a white or purple, chevron-shaped watermark on them. Leaf petioles (especially on older leaves) are as long or longer than the leaf blades; this is a diagnostic feature for identifying Palmer amaranth. The species produces male and female flowers on separate plants (this is defined as being dioecious). Flowers are primarily produced on long (up to 2-3 feet or more in length) and minimally branched, terminal flower spikes. Female Palmer amaranth flowers can be distinguished from waterhemp by the presence of sharp bracts.

Waterhemp is also an upright/erect pigweed species (growing to heights of 5-7 feet) that is native to the Midwestern US. It is often confused with Palmer amaranth because of similarities in form. The stems of common waterhemp are also smooth (hairless) and range from green to red in color. Although leaf shape can be variable, most leaves (especially older ones) are long and slender/narrow; leaves are typically dark green and shiny. Unlike Palmer amaranth, leaf petioles are shorter than leaf blades. Waterhemp is also dioecious; flowers are primarily produced on long (up to 1 foot or more in length) and terminal flower spikes. Unlike Palmer amaranth, the female flowers are not subtended by sharp bracts. A blog post describing the physical differences between the most commonly occurring weedy pigweed species in California can be accessed at: https://www.ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=27501.
Palmer amaranth is a commonly occurring weed in the San Joaquin Valley although waterhemp appears to be a recent invader. Prior to 2018, waterhemp occurrences were limited to wetlands in the Sacramento Valley and along roadsides. The most recent waterhemp sightings have been dense populations lining the edges of corn fields and irrigation canals in Merced County although putative observations have been reported in neighboring counties. It would be troublesome for growers if both species were to gain strong footholds in California's agronomic cropping environments; Palmer amaranth and waterhemp can grow very large (up to 7 to 8 feet in height or greater) very rapidly (inches per day in some environments) and can produce prodigious amounts of seed (250,000 to 1,000,000 per female plant).

PALMER AMARANTH VS WATERHEMP

	Palmer amaranth	Waterhemp
Leaf shape	Diamond-shaped, sometimes with a white chevron	Dark green, long, narrow and oval
Petiole	Longer than leaf blade	Shorter than leaf blade
Location of flowers	Terminal spikes and leaf axils	Terminal spikes and leaf axils
Bracts (with flowers)	Yes, sharp, with female flowers	No

Figure 1. A summary of morphological differences between Palmer amaranth and common waterhemp.

Both species are dioecious and rely on wind-mediated pollen dispersal for the transfer of genetic traits, which includes herbicide resistance. Throughout the US, Palmer amaranth populations have been identified with resistance to glyphosate, ALS inhibiting herbicides, microtubule inhibitors, PPO inhibitors, HPPD inhibitors, PS II inhibitors and synthetic auxins, plus multiple resistances to combinations of two and three of these herbicides/modes of action. In California, Palmer amaranth populations with resistance to glyphosate have been confirmed although it is not yet known how widespread the trait is, geographically. With respect to waterhemp, biotypes with multiple resistances to four (glyphosate, and ALS, PPO, and PS II inhibitors), five (auxins and ALS, PS II, PPO, and HPPD inhibitors), and six (glyphosate, auxins, and ALS, PS II, PPO, and HPPD inhibitors) modes of action have been identified. The full extent of the distribution of this species in the Central Valley is also not known. Furthermore, it is unknown where the waterhemp in California was introduced from; it may have arrived with agricultural commodities from regions with incidences of herbicide resistance. Surveys will be conducted in 2019 (and beyond) to describe the geographic dispersion of both Palmer amaranth and waterhemp and to describe their resistance profiles.

Seasonal Split-Application Treatments with CleanTraxx® in Forestry. Will Hatler, Corteva agriscience, Ed Frederickson, Thunder Road Resources, Beau Miller, Corteva agriscience

CleanTraxx® herbicide controls broadleaf, annual grass weeds and some woody brush seedlings when applied as a pre-emergence or early post-emergence application for conifer site preparation, conifer release and forest roadsides. It is labeled for use in CA, OR, and WA forestry as a Special Local Needs (SLN) label. It has excellent conifer tolerance especially on those species that are not tolerant to hexazinone. Commercial foresters have tested and utilized a split fall/spring application of CleanTraxx® rather than a single spring application, with good results. Trials were initiated in 2017 and 2018 in CA and OR to validate the efficacy of the split-season program and determine what rates provide the best overall control. Initial results confirm that split-season applications of CleanTraxx® outperform single season applications for overall weed control and bare ground in forestry. Increased rates of CleanTraxx® provided better weed control in trials conducted in OR, while there was no clear rate response seen in CA trials. Final results from trials established in 2018 are pending.

Economics and Low-cost Control Methods for Medusahead. Jeremy James, Rec Director, UCCE Sierra Foothills

The invasive grass medusahead dominates millions of acres of rangeland across the West. While the ecological impacts of medusahead on rangeland ecosystem function have been well demonstrated the economic impacts of this species are poorly understood and many tools available to control this and similar species are relatively expensive to apply. Here we quantify the effects of medusahead abundance on beef cattle gains and evaluate the potential of using low rates of aminopyralid to control medusahead in a cost effective manner. We stocked pastures with different levels of medusahead abundance with steers from March to beginning of May in both 2016 and 2017. There was little evidence that medusahead abundance influenced average daily gain ($P > 0.05$) but across both years increasing medusahead abundance reduced carrying capacity. On average a 10% increase in medusahead abundance decreased gains by 30 lbs per acre over the growing season. In a separate set of pastures we applied different rate of aminopyralid in fall and spring or left the pasture untreated. While most rates and timing of herbicide application reduced medusahead we found that it was possible to apply very low rates of aminopyralid in spring when medusahead was in the boot stage and sterilize over 95% of medusahead seed. Together these data allow land managers access to a low cost tool to control medusahead and identify when treatment benefits will exceed costs.

Field Release and Host Range Testing of Two Biological Control Agents that Attack Cape-Ivy.
Scott L. Portman* and Patrick, J. Moran (USDA-ARS, Invasive Species and Pollinator Health Research Unit)

Cape-ivy (*Delairea odorata*, Asteraceae) is a vine-like perennial that has established in riparian and coastal scrub habitats along the entire length of the California coastline. It is now considered one of the worst plant invaders in the State because it grows and spreads rapidly, smothering native plants, shrubs, and small trees, causing significant declines in biodiversity and integrity of natural habitats. Beginning in October, 2016, the first biocontrol agent in the world targeting Cape-ivy, a host-specific shoot tip galling fly (*Parafreutreta regalis*, Diptera: Tephritidae), has been released at multiple locations along the California coast. Field releases have resulted in field galls at every site, and galls indicative of second generation field reproduction have been found at one or more locations. Release sites are currently being monitored to determine gall survival during the winter months and agent establishment. Host range testing for the second biological control agent, a leaf mining moth (*Digitivalva delaireae*, Lepidoptera, Glyphipterigidae), is in the final stages. This insect shows no evidence that it can complete its development on any native species, or cause significant native plant damage.

"Eight Feet Tall and Thorny: Recent Attempts to Control Scotch Thistle (*Onopordum Acanthium)*"
Tom Getts, UCCE Advisor, Lassen County, tjgetts@ucanr.edu

Scotch thistle (Onopordum Antcanthium) is a biennial plant that can be problematic under a variety of rangeland conditions. It is highly invasive and is listed on noxious weed lists in ten western states. Populations of Scotch thistle in Northeastern California are widespread and still expanding under active management. While mechanical control can be utilized on small infestations, herbicides are often chosen for controlling large infestations. In the fall of 2016, a study was implemented outside of Doyle, California, to investigate applications of various herbicides ability to provide control of Scotch thistle rosettes. Local research previously had focused on spring applications, where this project investigated both fall (2016) and spring (2017) applications. Assessment of Scotch thistle control, and the effect on other non-targeted vegetation composition, was conducted periodically throughout the 2017 and 2018 growing seasons. Fall applications of Method (aminocyclopyrachlor), Milestone (aminopyralid), Telar (chlorsulfuron) and Method + Esplanade (indaziflam) provided greater than 90% control throughout the 2017 growing season. In August of 2018, 22 months after fall applications, only Telar and Method + Esplanade gave greater than 85% control. Spring applications of Milestone and Method gave more than 90% thistle control throughout the 2017 growing season. Sixteen months after treatment in August of 2018, greater than 90% control was still observed for spring applications of Milestone and Method. In most treatments, Scotch thistle cover was replaced with large increases in winter annual grass cover (cheatgrass and foxtails). However, applications of Method + Esplanade suppressed winter annual grass populations, resulting in increased cover of perennial grasses, perennial broadleafs and bare ground.

Broomrape Resurgence: A Concern for Tomato Production and Other Crops

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Within the last decade and increasing over the last few years, branched broomrape (*Orobanche ramosa*) infestations in several California processing tomato fields has been confirmed. CDFA regulatory 'holds' were placed on the infested tomato fields and crop was not harvested to prevent movement of seed with equipment. One of the 8 fields was historically infested ~30 years ago. That case reinforces reports in literature that broomrape seeds survive well. Additionally, an introduction of Egyptian broomrape (*Orobanche aegyptiaca*) into a northern California field, the first report of this species in the United States, is a stark example of unknowingly introducing a harmful parasitic weed pest. Fumigation is costly at ~$4K per acre, more than typically a tomato grower can afford. With this new species pest introduction, the California tomato industry, together with CDFA emergency funds, cooperated on eradication. How would anyone know ahead of time that a field was infested with the tiny speck of a broomrape seed? And before these parasitic weeds emerged as a foreign-looking plant to trigger an alert, how many tractors and people pass through the field as unsuspecting potential carriers to spread the seeds?

When an ounce of prevention is worth much more than a pound of cure. Vigilance with sanitation may reduce the introduction of unwanted pests. Perhaps field sanitation should be an adopted routine for all of us as personnel scouting fields as well as for equipment operators and irrigators. The dilemma for a grower and a pest control advisor who discover broomrape is: 1) report and forfeit the crop or 2) self-police and critically risk further seed spread within the field and potentially into new fields downwind, downstream and with equipment.

The Industry Response? How many more discoveries are needed to trigger a collective response toward eradication? Will the industry accept the presence of broomrape without quarantine? The Israeli approach is to control the pest much like another weed within the season because the infestation is widespread. The question remains for us in California: left unchecked and without government quarantine, how big of an agronomic problem will broomrape become? If the new species outbreak represents the norm, the problem is serious and would likely worsen without a unified eradication effort. A quarantine program without an economic means to eradicate the pest is not a solution.

How can such tiny seeds present such big problems?

Optimizing Herbicide Performance in Vegetables. Jesse M. Richardson, Corteva agriscience, jmrichardson@corteva.com

Application of Kerb® SC herbicide through overhead sprinklers has become the dominant weed control tactic in lettuce (Lactuca sativa) in the low desert production areas of Arizona and Southern California. It is also becoming increasingly commonplace in coastal production areas. To enjoy the full benefits of this technology, it is important to avoid application errors. Chemigating prematurely after initiating germination irrigations results in inadequate distribution of pronamide in the weed seed germination zone, causing inconsistent weed control. Inadequate chemigation or incorporation water volume can result in excess concentration of pronamide in the seed germination zone. Excess chemigation or incorporation water can result in an outcome similar to chemigating prematurely. Chemigating during excessive wind or through sprinklers that are in poor condition can lead to uneven distribution of the herbicide, resulting in poor weed control.

Bed-top application of GoalTender® for transplanted cole crops is an important management option. To optimize herbicide performance, it is important to apply the product in sufficient spray volume. The label mandates a minimum of 20 gallons of water per acre, but higher volumes will result in even better herbicidal performance. Disturbing the soil surface after making an application of GoalTender may provide openings for weed seedlings to emerge. Keeping the treated soil surface intact is recommended. At least 0.25 inch of either irrigation or rainfall is required to activate GoalTender after application. Furrow and drip irrigation immediately after transplanting can result in increased crop injury. Sprinkler irrigation is specified during early establishment of transplants. Planting cole crop transplants either too deep or too shallow in GoalTender treated soils is not advised.

Following label directions relating to application parameters will result in consistent, effective weed control in vegetable crops.

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Dacthal, its Essential Role in Vegetable Crop Weed Control.

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Dacthal (aka DCPA or chlorthal-dimethyl) is a selective pre-emergence herbicide used for controlling annual grasses and certain broadleaved weeds. In California, agricultural uses are primarily for vegetable crops, though Dacthal is also registered for use in turf, ornamentals, and strawberries. Dacthal was registered in 1958 when regulatory costs were much cheaper and the registration process much simpler than today. Dacthal is a niche herbicide used in crops with few alternative herbicides that have similar selectivity and efficacy as Dacthal. For example, in direct-seeded dry bulb onion Dacthal is the most selective herbicide available for use on sensitive young onion seedlings, and there is no obvious alternative. In crops like radish, gai lon and Bok choy, i.e., the minor Brassicas, there are no alternatives to Dacthal because these niche crops have no replacement for Dacthal. For crops like broccoli and cauliflower, the situation is somewhat better than the minor Brassicas. Dacthal is important in seeded broccoli due to its excellent crop safety in seedling broccoli. However, increasingly broccoli is transplanted and transplanted broccoli has oxyfluorfen as an option. Additionally, seeded and transplanted broccoli also has the option of postemergence applications of the oxyfluorfen formulation, Goaltender, which is labelled for pretransplant and postemergence use on broccoli and cauliflower.

The Dacthal mechanism of action is inhibition of mitosis by interference with microtubule formation, i.e., the microtubules do not line up properly and the cell cannot divide. Dacthal is a preemergence herbicide that controls susceptible weed seedlings during germination, but is not active on emerged weeds. Susceptible weeds do not emerge because Dacthal inhibits germination and meristem growth (Shaner et al. 2014).

While Dacthal tends to be relatively immobile in the soil, the degradates monomethyl tetrachloroterephthalic acid (MTP) and tetrachloroterephthalic acid (TPA) are more mobile and persistent (USEPA, 2008). In general, Dacthal parent material is not very mobile in soil because it has low water solubility and a high soil adsorption coefficient. Dacthal is also moderately persistent with an aerobic soil metabolism half-life in the range of 17.7 to 38.8 days and a half-life ranging from 8 to 34.8 days. The metabolite MTP is mobile in soil due to its high water solubility (3,000 mg/L) and low soil adsorption coefficient (30 cm3/g). However, MTP is not persistent with an aerobic soil metabolism half-life of 2.8 days (Wettasinghe and Tinsley, 1993). The metabolite TPA is both mobile in soil, with high water solubility (5,780 mg/L) and negligible soil adsorption potential, and persistent in soil, with an aerobic soil metabolism half-life of more than 300 days (Wettasinghe and Tinsley, 1993). Dacthal is most active on certain small seeded broadleaf weeds like common lambsquarters and common purslane as well as grasses. Weeds in the mustard family are not susceptible to control by Dacthal, which stands to reason as this herbicide is used in mustard green crops and closely related cruciferous vegetables like bok choy and radish (Dacthal 2018).

The label for Dacthal Flowable Herbicide acknowledges the potential for TPA leaching by advising against applications to well-drained sand and loamy sand soils with high water tables. The label also indicates a potential for surface water contamination via spray drift and advises against applications in wet and/or poorly drained areas. Detections of Dacthal acid degradates in well water samples in a number of California counties (Lohstroh and Koshlukova, 2017; GWPP 2016) has prompted the California Department of Pesticide Regulation to begin a formal review process of Dacthal and its degradates, (MTP and TPA) as part of the Pesticide Prevention Contamination Act (http://www.cdpr.ca.gov/docs/emon/grndwtr/pcpa_review.htm).

Primary use of Dacthal herbicide in California is in cole crops, broccoli, brussels sprouts, cabbage, cauliflower, kale (collards) and kohlrabi (Table 1). Other cruciferous vegetables plantings that use Dacthal include Chinese cabbage, bok choy, Gai lon (Chinese Broccoli), radish, kale, rapini, mustard and turnip. Dacthal is an important herbicide among the Allium group of vegetables such as dry bulb onion, green onion and leeks. Bulb onion is planted by direct seeding throughout California. Onions seedlings are slow to emerge and grow thus are delicate and susceptible to herbicide injury.

Because of the cropping scheme on the high-value lands of the coastal valleys, often two, three or even four rotational crops are planted on the same acre in a given year. A Salinas Valley or Santa Maria Valley field may see broccoli, celery, lettuce and spinach all grown in the same year. Herbicides used in one crop absolutely cannot injure rotational crops, i.e., must have a short period of soil residual activity. Any herbicide that is to replace Dacthal must not carryover to injure rotational crops like celery, lettuce and spinach. Because Dacthal can be used on so many crops and has short life in the soil, carryover injury to rotational crops is not a major issue with this herbicide.

Dacthal use in California declined significantly in the 1990s and remains at relatively low levels since then. Table 1 shows a decline in Dacthal pounds applied in broccoli from 83,326 lbs to 66,794 lbs in 2014 and 2016 respectively. The main reasons for the decline were changes in cropping patterns of cole crops from direct seeded to greater use of transplants. Broccoli is established from seed and transplants, while cauliflower is established only from transplants. GoalTender is registered for use before transplanting in both broccoli and cauliflower (GoalTender 2018a,b). Additionally the registration of GoalTender as a postemergence treatment for broccoli and cauliflower in 2006 greatly reduced the need for Dacthal in these two crops (GoalTender 2006). GoalTender is safe to broccoli and cauliflower, and very effective on a number of key weeds. Additionally the removal of Dacthal from the market in 1998 to 2001 appeared to reduce demand for the product and set a low baseline demand for the product in the 2000's compared to 1993. The main concern for the loss of Dacthal would be for the small acreage crops dependent on this herbicide: Bok choy, Brussels sprouts, radish, kale, rapini, mustards, gai lon and kohlrabi. These crops do not really have a good alternative to Dacthal currently registered. Onion has no alternative to Dacthal in the at planting time slot.

The conclusion of this assessment of Dacthal use in vegetables is that it is an essential product for California vegetables.

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Table 1. Dacthal use by pounds active ingredient applied and acres treated 2014-2016 for the top 20 crops plus all other crops combined (sorted by total pounds AI for 2014-2016; CDPR 2017).

Crop	Pounds AI Applied			Acres Treated		
	2014	**2015**	**2016**	**2014**	**2015**	**2016**
Broccoli	83,326	73,867	66,794	23,746	20,026	20,520
Onion, Dry	41,086	49,822	51,525	7,980	8,841	8,861
Cabbage	10,349	7,672	11,377	2,451	1,915	2,727
Cauliflower	8,402	7,042	8,578	2,671	2,358	3,001
Chinese Cabbage	7,031	8,066	6,996	1,607	1,616	1,483
Bok Choy	6,706	4,820	7,179	1,605	1,060	1,546
Brussels Sprout	4,693	3,757	8,934	871	669	2,115
Radish	5,219	4,388	5,449	914	848	996
N-Outdr Flower	3,315	4,059	3,697	620	740	670
Kale	2,518	3,377	4,875	451	579	807
Rapini	3,106	3,276	3,001	1,336	1,428	1,283
Mustard	1,658	3,299	2,919	592	496	473
Leek	1,193	1,867	2,448	231	324	399
Gai Lon	2,626	940	1,130	543	218	251
Kohlrabi	258	3,072	416	55	674	85
N-Outdr Plants In Containers	530	1,321	1,823	57	138	229
Onion, Green	2,071	541	168	329	100	28
Soil Fumigation/Preplant	2,461	93		653	52	
Turnip	1,148	799	388	272	80	101
Uncultivated Ag	388	592	268	177	205	151
Others	1,178	1,400	974	296	243	182
Totals	189,470	184,280	189,572	47,490	42,642	46,008

Pre and Post Plant Herbicide Programs for Weed Management in Transplanted LSL Melons.

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Introduction

Harper melons, also known as LSL (Long Shelf Life) melons, are part of an emerging trend in the melon-growing regions of California. Purported benefits include less labor at harvest and prolonged superior quality at the grocery store. Examples of Harper-type melons are the Infinite Gold, Fiji, Caribbean King and Caribbean Gold. Due to grower and buyer interest, seed companies are rapidly expanding the number of varieties with this trait.

However, LSL varieties are expensive hybrids relative to older, open pollinated cultivars, and seed costs can become a significant portion of the total cost of production. In the San Joaquin Valley, typical production practices are 1 row per 80" bed and a target plant population of about 5000 plants per acre (final in-row spacing of 16"). Siegers Seed Company currently lists Caribbean Gold RZ, a LSL Harper type, for $582 per 5000 seeds. Harris lists Shockwave for $70 per 1000 seeds. Thus, one potential method to reduce seeding costs would be to use transplants at much wider spacing.

Switching to transplants for cantaloupes and honeydews can result in changes to the weed management program for these crops. For example, the use of pre-plant herbicides, such as Treflan (trifluralin), Sandea (halosulfuron), or Curbit (ethalfluralin) should be safe to use, since the transplant could be planted at a depth as to avoid contact with the herbicides. This is the similar tactic that it used for processing tomatoes in the state, where a Treflan + Dual tankmix is typically applied before transplanting. However, due to the different size of melon transplants, this needs to be evaluated for crop safety.

The objective of this trial was to evaluate the use of several common pre and post-emergent herbicides on weed control and crop safety in drip irrigated Harper-type LSL transplanted melons using mechanical and sprinkler irrigation methods.

Methods.

Trials were conducted at the UC Desert Research and Extension Center (DREC in Imperial County) and West Side Research and Extension Center (WSREC in Fresno County) evaluating weed management and crop safety from various pre and post plant herbicides in transplanted long shelf life (LSL) cantaloupes. Cultivar "Fiji" was used at both locations, and the seed of various annual broadleaf and grassy weeds were broadcast throughout the plot area prior to transplanting. Both locations used subsurface drip irrigation. At DREC, Sandea (halosulfuron) 1 oz/A, Curbit (ethalfluralin) 4 pts/A, and Prefar (bensulide) 6 qts/A herbicides were evaluated with and without sprinkler incorporation. Post plant treatments of Sandea 1 oz/A and clethodim 8 oz/A herbicides were made 4 weeks after transplanting (WAT). At WSREC, Sandea 1 oz/A, Curbit 4 pts/A, Prefar 6 qts/A, and Curbit+Prefar tank-mix were either sprinkler or mechanically incorporated. Sprinklers were used to incorporate the herbicides in the appropriate plots the following day with a 4-hour set. In total, there were 20 treatments: 10 with sprinkler incorporation and 10 with mechanical incorporation of the herbicides. At 4 weeks after transplanting (WAT), Sandea 1 oz/A, clethodim 4E at 8 oz/A, and Poast (sethoxydim) treatments were applied as an over-the-top application to select plots. No adjuvants were used for any of the POST treatments, and they were not sprinkler incorporated. Treatment design was a randomized complete block with 4 replications; plot size was one bed (6.67 ft) by 30 feet long.

At both locations, weed and crop phytotoxicity ratings were made at 2-week intervals throughout the growing season. A once-over harvest was performed by counting all fruit by size in each plot. Brix readings were done on 1 sample fruit from each plot using a hand held refractometer. The analysis of variance and means seperation were performed using Fisher's Protected LSD at $p < 0.05$.

Results

At DREC, weed control and fruit yields were significantly ($p \leq 0.05$) improved where sprinklers were used to incorporate the pre-emergent herbicides as compared to post applications of Sandea or clethodim. At 5 WAT, average weed control (grasses + broadleaf) was 91.5%, 75.5%, and 70.5% for Sandea, Curbit, and Prefar, respectively with sprinkler incorporation, but 47.7%, 67.2%, and 59.8% without (Figure 1). No crop phytotoxicity was observed in any of the treatments. All herbicide treatments with the exception of clethodim significantly increased total marketable yield with sprinkler irrigation; pre-plant Sandea had 74% yield increase as compared to the untreated control (Figure 2). Where the herbicides were not incorporated, however, yields were diminished and treatment affects were marginal. Soluble solids and the size 9% were not affected by incorporation method. Average Brix for this trial was 11.7%.

In contrast, at WSREC sprinkler incorporation did not provide adequate weed control, and in fact appeared to increase weed germination as compared to the mechanically incorporation. Pre plant Curbit, Sandea, and the Curbit+Prefar tankmix had significantly ($p \leq 0.05$) better broadleaf weed control at the end of the growing season with mechanical incorporation of 50.0%, 90.0%, and 90.0%, respectively, as compared to sprinkler irrigation (1.3%, 6.3%, and 1.3%) (Figure 3). Method of incorporation (mechanicial vs sprinklers), application timing (PRE vs POST) and the interaction of these two treatment factors were all highly significant ($p< 0.001$). Some temporary crop injury was noted in the Sandea and Curbit pre treatments regardless of incorporation method. Nonetheless, best marketable yield occurred in those plots where weeds were suppressed – yields were decreased more than 50% in the untreated check plot as compared to the hand weeded control. Best yields of 1700 boxes per acre occurred in the Sandea PRE + POST treatment (Figure 4). Culls, soluble solids, and the "jumbo"% were not significantly affected by any of the treatments. Average yield for this trial was 1418 boxes/A at 12.2 Brix.

The results from these trials show that pre-emergent applications of registered herbicides can be safe and effective in transplanted LSL melons provided they are properly incorporated. At both locations, the use of pre-plant applications of ethalfluralin (Curbit) and halosulfuron (Sandea) significantly improved weed control as compared to the other treatments and the untreated control plots. Crop phytotoxicity was also noted from these two herbicides, but the effect was temporary, and these plots resulted in the highest fruit yield and both locations. However, the effect of incorporation was not consistent. Using sprinklers to incorporate the pre-plant herbicides improved weed control at the DREC location, but reduced weed control at WSREC. This may have occurred because the irrigation set at WSREC was too short (only about 4 hours) to properly activate the herbicides, and instead increased weed seed germination.

Acknowledgements
Many thanks to Pratap Devkota (formerly, weed science advisor Imperial County), and UC WSREC and DREC staff for their help with these trials. This research was made possible through the financial support of the California Melon Research Board.

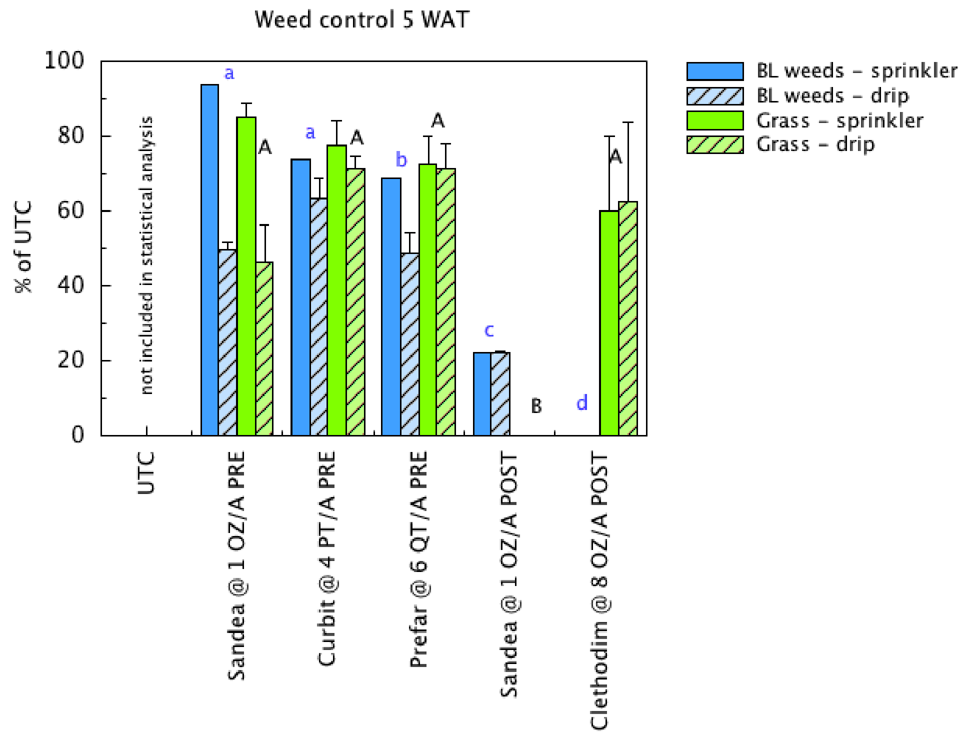

Figure 1. Weed control 5 weeks after transplanting as affected by herbicide treatment and incorporation method, DREC 2018.

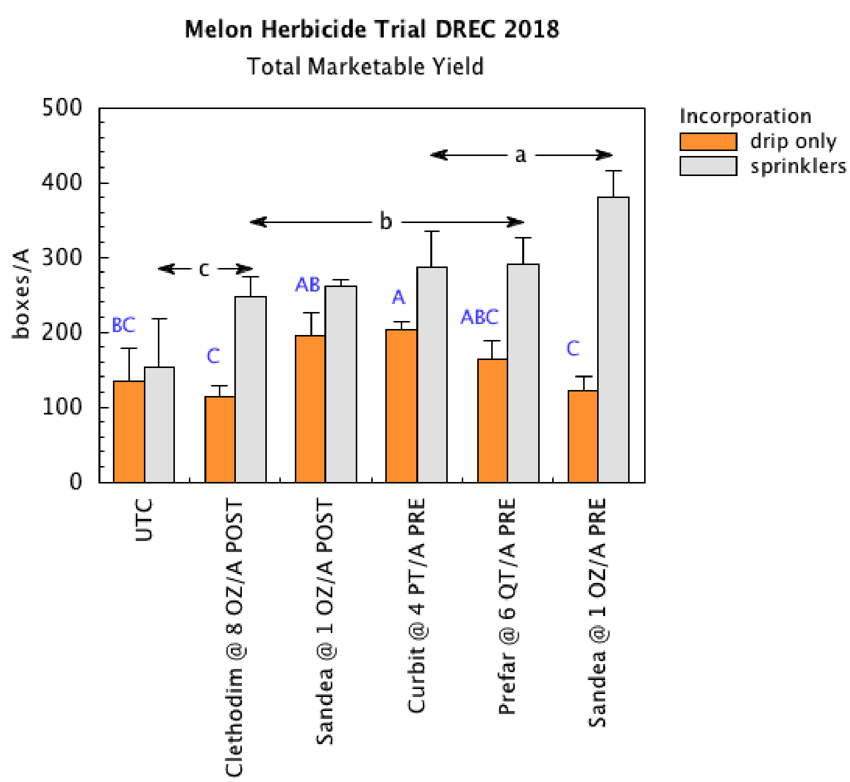

Figure 2. DREC melon yield as affected by herbicide treatments and incorporation method.

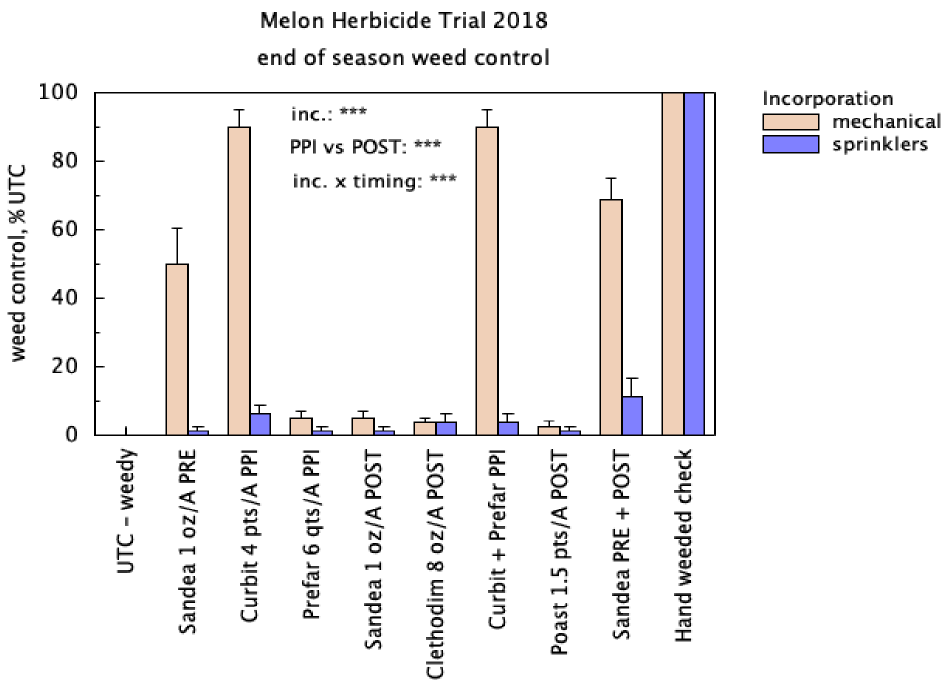

Figure 3. End of season weed control at WSREC as affected by herbicide treatment and method of incorporation.

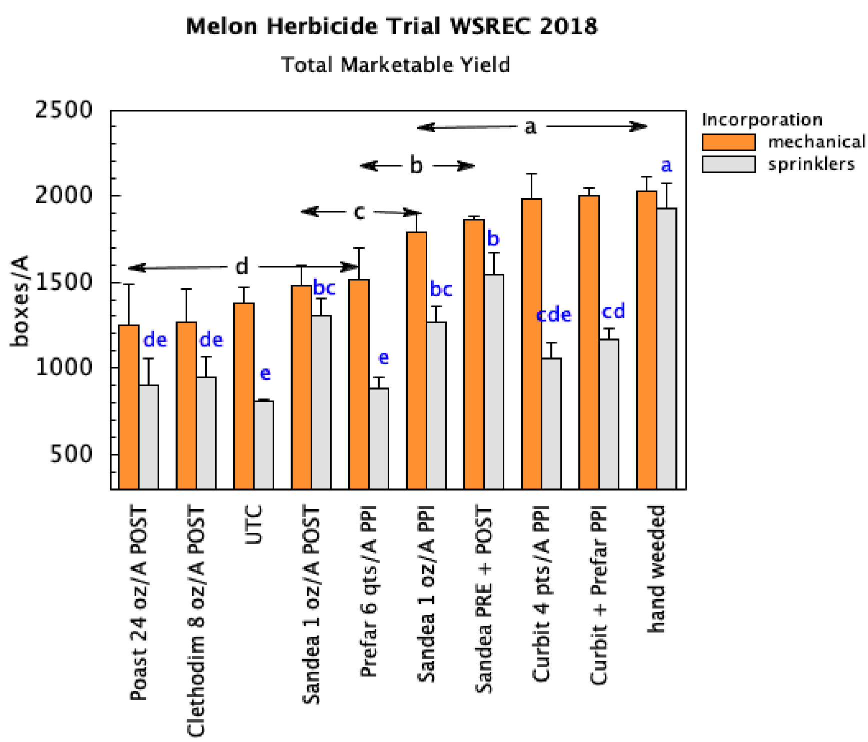

Figure 4. WSREC melon total marketable yield as affected by herbicide treatment and method of incorporation.

Best Practices to Keep Pesticides Out of Water. Samuel S. Sandoval*[1], L. A. Blecker[2]. [1]Professor and Cooperative Extension Specialist in Water Resources, UC Davis and UC Agriculture and Natural Resources, 1 Shields Ave. Dept. LAWR, Bldg. PES 1111, Davis, CA, 95616, [2]Lisa A. Blecker. Pesticide Safety Education Program Coordinator, University of California Agriculture and Natural Resources Statewide IPM Program, 2801 Second Street #157, Davis, CA 95618-7774. *Corresponding author (samsandoval@ucdavis.edu)

This presentation introduces the basic concepts of hydrology, pesticide chemical characteristics, site characteristics, and applicator practices that influence how contaminants – specifically pesticides – get into the water system. Hydrologic principles illustrated include climatic drivers such as atmospheric rivers, how water moves in the landscape, and surface water and groundwater interactions. Pesticide chemical characteristics that increase the likelihood pesticides will move offsite via leaching include persistence and solubility. Pesticide chemical characteristics that increase the likelihood pesticides will move offsite via surface runoff include persistence, soil adsorption (measured in Koc) and the groundwater ubiquity score (GUS). We discuss best practices for water management and safe pesticide handling practices. These principles include proper pesticide selection for your site conditions, proper irrigation scheduling and precipitation monitoring, and storing, mixing, loading and handling any pesticide over an impermeable layer and 100 feet away from any stream or well. Applicators are instructed that they can use pesticides safely if they: following pesticide label instructions, follow California regulations, have good water management, and handle pesticides safely.

DPR's Surface Water Protection Program. Aniela Burant, PhD, California Department of Pesticide Regulation, Surface Water Protection Program, 1001 I St. Sacramento, CA 95812 Aniela.burant@cdpr.ca.gov

The California Department of Pesticide Regulation's Surface Water Protection Program (SWPP) is tasked with protecting California's surface waters from pesticide pollution in both agricultural and urban environments. SWPP achieves this mission through the following key activities: a) evaluation of pesticide products for registration in California, b) the modeling of the fate and transport of pesticides to determine the estimated environmental concentrations and assess the environmental risk, c) long-term monitoring of high use pesticides with high aquatic toxicity in surface water and sediment, d) assessment of monitoring data to inform decision making on mitigation and regulatory actions, e) funding and directing research to address data gaps including the effectiveness of best management practices used to mitigate the offsite movement of pesticides, f) conducting outreach to pesticide users on best management practices and regulatory updates. SWPP staff also work collaboratively with stakeholders, such as pesticide registrants, County Agricultural Commissioners, State and Regional Water Boards, pesticide users, and university researchers to implement and achieve the program's mission.

Glyphosate and Proposition 65: What is the Risk to Applicators? Michael S. Blankinship, Blankinship & Associates, Inc., 1615 5th St, Ste A, Davis, CA (530) 757-0941, mike@h2osci.com.

The recent listing of glyphosate as a carcinogen has prompted significant discussion on the risks posed to a variety of potentially exposed people, including applicators. This talk will address the differences between toxicity and risk, present methods to estimate exposure to pesticide applicators under several common application scenarios and estimate the potential risk to applicators relative the California Office of Health Hazard Assessment's No Significant Risk Level (NSRL).

Postemergence Herbicide Efficacy on Threespike Goosegrass in California Orchards. Drew Wolter, and Brad Hanson, University of California, Davis

Threespike goosegrass (*Eleusine tristachya*) is related to the more widely distributed goosegrass (*E. indica*). While goosegrass is a large stature and erect annual, threespike goosegrass is a tufted low growing perennial (or semi-perennial) grass of growing concern in California's Central Valley orchard production systems. Field studies were conducted in Chico and Livingston, CA to evaluate the performance of several postemergence herbicide control options. Three graminicides: sethoxydim, clethodim, and fluazifop all controlled tillered E. tristachya with greater than 75% efficacy, five weeks after treatment (WAT). Non-selective glyphosate treatments applied at a common field rate and twice that rate proved to be the least efficacious, with less than 54% control five WAT. Tank mix treatments of glyphosate plus another herbicide had varying level of control five WAT, including glyphosate + rimsulfuron (37% control), glyphosate + oxyfluorfen (56% control), and glyphosate + glufosinate (67% control). The results from this study indicate that ACCase inhibitors such as fluazifop, clethodim, and sethoxydim provide the greatest control of E. tristachya, while glyphosate provides poor management of this species.

Response of Glyphosate-Susceptible and Resistant Palmer Amaranth to Environmental Stresses During Germination and Growth. Samikshya Budhathoki[1], Lynn Sosnoskie[2], Anil Shrestha[3], [1]Department of Plant Science, California State University, Fresno, CA., [2]University of California Cooperative Extension, Madera/Merced, CA, [3]Department of Viticulture and Enology, California State University, Fresno, CA

Much of the area in California's southwestern San Joaquin Valley (SJV) is prone to moisture stress and high soil-salinity conditions. In recent years, glyphosate-resistant (GR) biotypes of (Amaranthus palmeri) have been confirmed in the SJV. However, it is not known if these biotypes are more- or less-fit than the glyphosate-susceptible (GS) biotypes in such environments. Therefore, two studies were conducted to assess the effect of a) moisture stress and salinity on the germination of a confirmed GR and a GS biotypes of Palmer amaranth, and b) salinity on the growth of these biotypes. Moisture stress at germination was simulated by preparing polyethylene glycol solutions ranging from 0 to 5.56 MPa. Salt stress at germination was assessed under sodium chloride solutions ranging from 0 to 25 dS m-1 electrical conductivity (EC). Germination tests were conducted in petri dishes lined with filter paper and placed in a controlled environment chamber set at 25° C. The experiment was arranged as a completely randomized design and data were analyzed using analysis of variance ($\alpha = 0.05$) and non-linear regressions. Effect of salinity on these biotypes were also assessed by monitoring growth of potted plants kept outdoors under sodium chloride solutions ranging from 0 to 20 dS m-1 EC. Germination of GR and GS seeds were affected differentially by EC. The GR seeds exhibited greater germination at a higher EC than the GS seeds. Approximately 8% of the GR seeds germinated at 20 dS m-1 whereas, only 2% of the GS seeds germinated at 15 dS m-1. However, both biotypes showed similar response in germination to moisture stress. Approximately 25% of the seeds germinated at -0.51 MPa and there was no germination at the lower water potential levels. Both GR and GS plant growth was affected similarly by EC. The total aboveground dry biomass decreased curvi-linearly with increasing EC levels. Averaged over biotypes, biomass at 5, 10, 15, and 20 dS m-1 was 100, 76, 49, and 42% of the control (0 dS m-1), respectively. Results from these studies suggest that the GR population used in the trial is not less fit than the GS biotype, under the conditions of these studies. In 2018, seed samples from Palmer amaranth and common waterhemp (A. tuberculatus) populations were collected from several areas of the Southern SJV to describe their responses to herbicides and environmental stresses.

ALS Cross-Resistance and Multiple-Resistance in California Accessions of Cyperus difformis.

Alex Ceseski, K. Al-Khatib, University of California, Davis

Control of smallflower umbrella sedge (*Cyperus difformis* L.) in California rice has relied heavily on acetolactase synthase (ALS) inhibiting herbicides for more than two decades. As a result, smallflower populations resistant to ALS inhibitors are found throughout California's rice growing region. In addition, grower complaints indicate that multiple-resistant smallflower may be a budding concern.

The present research seeks to evaluate the level of resistance of ALS-resistant California smallflower populations, and to determine if multiple-resistance exists within select smallflower populations. Sample populations from previously-determined ALS cross-resistance patterns were self-pollinated and the progeny were subjected to dose-response studies with the ALS-inhibitors Londax (bensulfuron), Halomax (halosulfuron), Regiment (bispyribac), and Granite (penoxsulam), at rates ranging from 0.2x to 12x. In addition, these populations were screened at 0.5x to 3x field rates for multiple resistance to Stam (propanil), Shark (carfentrazone), and Abolish (thionbencarb).

Dose response studies confirm that one population is strongly resistant to all of the ALS inhibitors used in the study, regardless of application rate. This resistance is possibly due to a mutation causing insensitivity to the target enzyme. Another population is strongly resistant to each ALS inhibitor *except* Halomax, to which it is susceptible even at 0.5x field rate. All other populations' tolerance/ resistance appears to be dose-dependent.

Multiple-resistance studies indicate that none of the tested populations were tolerant/ resistant to Shark or Abolish, however many appear to have a dose-dependent tolerance to Stam. When treated with Stam, all populations except one had <50% mortality at the 0.5x rate, three populations had <50% mortality at the 1x rate, and all populations had >80% mortality when treated with Stam at 3x field rate.

Future research will seek to uncover the precise mechanisms of ALS resistance in these populations.

Characterizing the Expression of Candidate Genes for Herbicide Resistance in the Agricultural Weed Hairy Fleabane (*Erigeron bonariensis*). Priyanka Chaudhari*[1], Diana Camarena[2], and Katherine Waselkov[2]. [1] Biotechnology Department, California State University, Fresno, CA, USA, [2] Plant Physiology Department, California State University, Fresno, CA, USA, [2] Biology Department, California State University, Fresno, CA, USA. *[2] Diana Camarena (sweetdc@mail.fresnostate.edu), *[2] Katherine Waselkov (kwaselkov@csufresno.edu)

Herbicide resistance is the heritable ability of weeds to survive and reproduce in the presence of herbicide doses that are lethal to the wild type of the species. *Erigeron bonariensis* (hairy fleabane) is an agricultural weed that infests orchards and crop fields in California's Central Valley, and has become resistant to the herbicide chemical glyphosate (RoundUp®), through an unknown genetic mechanism. One mechanism of glyphosate resistance demonstrated in *E. canadensis*, a close relative of *E. bonariensis*, is a non-target site reduction in translocation of the herbicide, in which vacuolar sequestration prevents the chemical from spreading around the plant. Resistance of *E. canadensis* to glyphosate is believed to involve upregulation of the target gene *EPSPS* in combination with the ABC transporter genes *M10* and *M11*. This study aims to determine through quantitative PCR (qPCR) if these candidate genes are involved in glyphosate resistance in wild populations of *Erigeron bonariensis*. Sample leaves of *E. bonairensis* were collected before and after glyphosate spraying in plants from 10 different wild populations from the Central Valley and two control populations. Response to glyphosate was used to characterize percent resistance for each wild-collected population. RNA was extracted from the leaves of glyphosate-treated and untreated individuals, and used for cDNA synthesis. Quantitative PCR primers were designed for the *E. bonariensis* orthologues of the *E. canadensis* genes *EPSPS*, ABC *M10*, and ABC *M11*, and pre- and post-spraying expression levels of each gene (relative to the housekeeping gene actin) were analyzed through qPCR. This experiment indicates that *EPSPS* expression is not significantly involved in resistance, and that Central Valley populations have different resistance level, and different gene expression level, and therefore evolved glyphosate resistance multiple times independently. Future RNA-Seq analysis via Illumina HiSeq may reveal other genes that are differentially up- or down-regulated in resistant populations of *E. bonariensis* after glyphosate exposure. Determination of the genetic basis of herbicide resistance will provide fundamental data about parallel evolution in response to strong selection pressures, and suggest alternative mechanisms for field control of this weed.

Clomazone Metabolism in Bearded Sprangletop. Katie E. Driver*, Caio Brunharo, Kassim Al Khatib, and Amar Godar. University of California, Davis. *Corresponding author (kemccauley@ucdavis.edu)

Bearded sprangletop (*Leptochloa fusca* (L.) Kunth ssp. *fasicularis* (Lam.) N. Snow) is a problematic weed in California rice production, however few herbicides provide control. As control of bearded sprangletop has declined, suspicion of resistance has increased due to the continuous rice cropping system. Four populations were confirmed resistant to clomazone. Clomazone resistant bearded sprangletop plants were initially injured but began to recover 14 DAT. Resistance levels ranged from 1.25 to 5 times the use rate of clomazone. Patterns of resistance suggest metabolic resistance is the mechanism of resistance. Laboratory experiments were conducted to determine the metabolites present. Plants were treated with ^{14}C clomazone and harvested at 48 and 72 hours. The plants were ground with liquid nitrogen and 14C levels quantified with liquid scintillation counting. Following quantification, plants were suspended in acetic acid: acetonitrile and analyzed using HPLC and radio flow detection.

Potential Use of Remote Sensing in Vineyard Weed Management. Cody Drake1, Luca Brillante2, Ming-Yi Chou3, and Anil Shrestha2, 1Department of Plant Science, California State University, Fresno, CA, 2Department of Viticulture and Enology, California State University, Fresno, CA, 3St. Supéry Estate Vineyards and Winery, Napa, CA

In recent years, application of drones and remote sensing technology is being explored for various management aspects in agricultural cropping systems, including vineyards. However, these technologies have not been explored adequately for weed management. Although a necessary practice to improve efficiency in weed control, ground scouting of the weeds within the vine row, especially, during the growing season can be cumbersome and labor intensive. Therefore, non-selective herbicides broadcast and/or intensive mechanical weeding are generally applied in the entire field.

Early identification of critical zones by aerial images obtained through drones would enable site-specific weed management in vineyards and avoid broadcast application of postemergence herbicides. Therefore, the objectives of this study were to: i) evaluate high-resolution aerial images of weed presence in a commercial vineyard as a tool to assess weed pressure, ii) select management zones for site-specific weed management and correlate weed pressure next to a vine with vine vigor, iii) test and ground-truth aerial images for weed identification.
Experiment was carried-on in an herbicide-free wine grape vineyard in Napa County, where inter-rows were disked using a Tandem Disc (Schmeiser, Selma, CA) while under-vine weeds were mechanically managed using a Radius weeding blade (Clemens, Woodland, CA) multiple times throughout the growing season. Aerial images were obtained by a drone (DJI M100) equipped with a visual (DJI Z3) and a multispectral camera (SlantRange 2P). Two different fly heights were tested: 30 m, and 10 m above the vineyard floor with a respective resolution of 0.5 cm px-1 and 1 cm px-1. On the basis of field NDVI two management zones were separated by k-means clustering and within them coverage rate, dry biomass, and weed identification was performed in three different locations. For mapping and visualization, image mosaics were obtained with DroneDeploy, data analysis and modeling was run in R.

Preliminary results showed that areas of weed presence could be successfully identified by the drone images. Vine vigor was not negatively correlated with the density or biomass of the weeds. The resolution of the images were good enough for several of the species to be identified from the images. This was confirmed with on-spot sampling at several random sites in the vineyard. Although the study is ongoing, it can be concluded that remote sensing with drones can be integrated as a site-specific weed assessment tool in vineyards

Effects of Moisture and Salt Stress on Germination of Field Bindweed (*Convolvulus arvensis*). Idalia Navarro[1] and Anil Shrestha[2,] [1]Department of Plant Science, California State University, Fresno, CA., [2]Department of Viticulture and Enology, California State University, Fresno, CA

Field bindweed is a major weed in annual and perennial cropping systems in California. It is a perennial species and is often difficult to control with chemical or non-chemical methods. This species is present in the western part of Fresno County and its prevalence seems to be increasing in this region that is semi-arid and has several areas with high salinity soils. Very little information is available on seed germination biology and ecology of this species in the local context. Therefore, two experiments were conducted to assess: a) the effect of water stress, and b) salt stress on germination of locally collected seeds. Water stress was simulated by preparing polyethylene glycol solutions ranging from 0 to 5.56 MPa. Salt stress was assessed under sodium chloride solutions ranging from 0 to 25 dS m^{-1} electrical conductivity. Germination tests were conducted in petri dishes lined with filter paper and placed in a controlled environment chamber set at 25° C. The experiment was arranged as a completely randomized design and data were analyzed using analysis of variance and non-linear regressions. Results indicated that this species is very moderately tolerant to drought because germination ceased beyond 0.51 MPa. However, it is very tolerant to salinity because approximately 25% of the seeds germinated at the highest level (25 dS m^{-1}) of electrical conductivity. These findings suggest that field bindweed can invade highly saline soils provided adequate moisture is available for germination

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Alkaliweed (*Cressa Truxillensis*): A New Problematic Species in Crops and Non-Crop Areas of the San Joaquin Valley. James Schaeffer[1,2], Kurt Hembree[2], and Anil Shrestha[1,] University of California Cooperative Extension, Fresno, CA[1,] California State University, Fresno, CA[2]

Cressa truxillensis, more commonly referred to as alkaliweed, is a plant native to California and is rapidly becoming a problematic species in the southern San Joaquin Valley cropping systems and irrigation ditchbanks. Its rapid spread in these areas, in recent years, has caught the attention of growers, consultants, and extension people. Alkaliweed is a perennial plant and member of the Convolvulaceae family. Alkaliweed has been observed in multiple counties in the San Joaquin Valley, including Fresno, Madera, and Kings. More severely, alkaliweed has become established in young pistachio orchards with little shading and seems to be spreading rapidly. So far, growers have been unsuccessful in controlling established alkaliweed plants with repeated postemergence herbicides. Very limited literature is available on the biology and management of this species, and no research has been conducted looking at control options. Therefore, there is an urgent need to develop such information to prevent it from being a serious problem in the future. The objective of this study was to develop preliminary information on the biology, distribution, and chemical management of this species. Research is being conducted on this plant to determine its biology and growth characteristics under different shade and moisture conditions to be able to develop a better understanding of its biology, so potential effective chemical and/or physical control methods can be developed. Preliminary research using systemic and contact herbicides has produced only minimal suppression. Postemergence herbicides will be applied during early-winter, followed by additional spring treatments to document plant fitness. Additional trials during spring and summer will be conducted to determine plant response to light depravation, moisture content, and other stimuli. Furthermore, plants will be potted and grown in a greenhouse to monitor their above- and below-ground growth. It is expected that these studies will generate information that is essential for the management of this species.

Effects of Sudangrass Cover Crop Management Techniques and Soil Solarization on Weed Population and Seed Germination in Organic Strawberry Production. Timmy Jacobs, Student, California Polytechnic State University, San Luis Obispo

Weed control is a major cost for organic growers, and there is a critical need for innovative, chemical-free weed management techniques. Soil solarization has proven to provide effective weed control comparable to that of other alternatives to synthetic herbicides. Additionally, the incorporation of grass cover crop residues into soil during soil solarization has shown to enhance weed control efficacy Field and lab experiments were conducted to determine the efficacy of Sudangrass (*Sorghum X drumondii*) cover crop management techniques and soil solarization on important agricultural weeds in organic strawberry production in Central California. Lab experiments assessed the time needed to kill weed seeds at temperatures typically achieved during soil solarization (40C, 45C, 50C, 55C, 60C) in California. Seeds tested included *Malva parviflora, Erodium cicutarium, Sonchus oleraceus, Portulaca oleracea and Picris echioides*. Heat treatments had reduced effectiveness in controlling hard seeded weed species *M. parviflora* and *E. cicutarium* and warm season annual *P. oleracea.* No germination was oberserved in annual species *S. oleracea and P. echioides* after exposure to 40C for 96h and in 0.5h at 55C. Field experiments tested soil solarization and Sudangrass cover crop treatments on weed populations at the Cal Poly Organic Farm in San Luis Obispo, CA. Sudangrass was grown from May to July, terminated and either left on surface as mulch or incorporated into the soil. These two treatments and a control were tested alone and in combination with soil solarization. Soil was solarized using a 2.4 mil clear plastic tarp for 5 weeks from late July-August. Maximum soil temperatures achieved in solarized plots were 48C at 5cm and 42C at 15cm. On average, solarized plots with mulched residue obtained temperature 2-3 C lower than other solarized plots without mulch. Seven weeks after the plastic was removed, plots with incorporated cover crop residues and no solarization reduced weed biomass by 24.4% compared to the control. Plots with mulched residues and no solarization reduced weed biomass by 95.6 percent. All solarized plots resulted in similar weed control, regardless of cover crop treatment with an average control of 97.1% $\pm$ 0.6%. Field results indicate that soil solarization and Sudangrass mulch can effectively control many annual weeds. However, given lab results, it may be difficult for coastal strawberry growers to achieve the lethal temperatures needed for hard-seeded weed species and *P. oleracea* via soil solarization.

California Weed Science Society
Financial Summary Report
July 1, 2018 through March 21, 2019

Ordinary Income/Expense	
Income	
4000 · Registration Income	113,241.00
4001 · Membership Income	1,365.00
4020 · Exhibit Income	22,200.00
4030 · Sponsor Income	7,250.00
4040 · CWSS Textbook Income	513.50
4065 · Orchid Fundraiser	400.00
4290 · Refunds	-241.50
Total Income	144,728.00
Gross Profit	144,728.00
Expense	
4300 · Conference Accreditation	205.00
4320 · Conference Catering Expense	56,112.74
4330 · Conference Equipment Expense	5,961.04
4360 · Student Awards/Poster Expense	2,000.00
4370 · Scholarship Expense	10,000.00
4380 · Conference Supplies	296.16
6090 · Advertising	1,800.00
6105 · Merchant Services Fees	4,796.53
6120 · Bank Service Charges	-1.00
6130 · Board Meeting Expenses	579.67
6135 · President's Reception	500.00
6240 · Insurance - General	3,277.00
6270 · Legal & Accounting	965.00
6280 · Mail Box Rental Expense	90.00
6307 · Outside Services - PAPA	34,665.20
6340 · Postage/Shipping Expense	56.00
6345 · Printing Expense	572.51
6350 · Promotional Item Expense	441.76
6355 · Website Expense	1,917.50
6440 · Office Supplies Expense	259.54
6530 · Travel - Transport/Lodging	876.03
6540 · Travel - Meals/Entertainment	60.00
6545 · Student Travel - Transport/Lodg	1,405.92
6550 · Student Travel - Meals	131.07
6555 · Speaker Lodging/Travel Expense	1,071.28
Total Expense	128,038.95
Net Ordinary Income	16,689.05
Net Income	**16,689.05**

Bank of America Checking Account Balance as of March 21, 2019 **- $53,993.57**

Edward Jones Investment Account Portfolio Summary as of February 22, 2019 **- $352,944.86**

CWSS HONORARY MEMBERS LISTING

Harry Agamalian (1983)
Norman Akesson (1998)
Floyd Ashton (1990)
Alvin Baber (1995)
Walter Ball *
Dave Bayer (1986)
Carl E. Bell (2010)
Lester Berry
Tim Butler (2008)
Mick Canevari (2008)
Don Colbert (2002)
Floyd Colbert (1987)
Stephen Colbert (2012)
Alden Crafts *
Marcus Cravens *
Dave Cudney (1998)
Richard Dana *
Boysie Day *
Nate Dechoretz (2003)
Jim Dewlen (1979)*
Paul Dresher *
Ken Dunster (1993)*
Matt Elhardt (2005)
Clyde Elmore (1994)
Bill Fischer *
Steven Fennimore (2019)
Dick Fosse *
Tad Gantenbein (2004)
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George Gowgani
Bill Harvey *
David Haskell (2009)
F. Dan Hess (2001)*
Floyd Holmes (1979)
Nelroy Jackson (1997)*
Scott A. Johnson (2013)
Warren Johnson (1977)*
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Bruce Kidd (2009)
Don Koehler (2003)
Jim Koehler
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Art Lange (1986)
Wayne T. Lanini (2011)
Michelle Le Strange (2015)
J. Robert C. Leavitt (2010)
Oliver Leonard *
Judy Letterman (2017)
Jim McHenry *
Bob Meeks
Bob Mullen (1996)
Robert Norris (2002)
Ralph Offutt
Steve Orloff (2017)*
Jack Orr (1999)
Ruben Pahl (1990)
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Murray Pryor *
Richard Raynor
Howard Rhoads *
Jesse Richardson (2000)
John Roncoroni (2018)
Ed Rose (1991)*
Conrad Schilling *
Jack Schlesselman (1999)
Vince Schweers (2003)
Deb Shatley (2009)
Conrad Skimina (2003) *
Leslie Sonder *
Stan Strew*
Huey Sykes (1989)
Tom Thomson (1999)
Robert Underhill
Lee VanDeren (1983) *
Ron Vargas (2001)
Stan Walton (1988) *
Bryant Washburn (1988)
Steve Wright (2007)

*Deceased

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2003 Dave Cudney & Clyde Elmore*
2004 Michelle LeStrange & Mark Mahady
2005 Scott Johnson & Richard Smith
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2009 Ellen Dean & Wayne T. Lanini
2010 Lars W.J. Anderson & Stephen F. Colbert
2011 Jennifer Malcolm & Hugo Ramirez
2012 Rob Wilson
2013 Rick Miller
2014 Carl Bell*, Brad Hanson & Anil Shrestha
2015 Deb Shatley & Barry Tickes
2016 Steven Fennimore
2017 Steven D. Wright*
2018 Kassim Al-Khatib & Scott Stoddard
2019 Josie Hugie & Scott Oneto

* Denotes President's Award for Lifetime Achievement in Weed Science

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CWSS 2019 ANNUAL CONFERENCE - AUTHOR INDEX

CALIFORNIA WEED SCIENCE SOCIETY

Conference History

CONFERENCE	DATES HELD	LOCATION	PRESIDENT
1st	February 16, 17, 1949	Sacramento	Walter Ball
2nd	April 4, 5, 6, 1950	Pomona	Walter Ball
3rd	January 30, 31, Feb. 1, 1951	Fresno	Alden Crafts
4th	January 22, 23, 24, 1952	San Luis Obispo	Murray Pryor
5th	January 20, 21, 22, 1953	San Jose	Bill Harvey
6th	January 27, 28, 1954	Sacramento	Marcus Cravens
7th	January 26, 27, 1955	Santa Barbara	Lester Berry
8th	February 15, 16, 17, 1956	Sacramento	Paul Dresher
9th	January 22, 23, 24, 1957	Fresno	James Koehler
10th	January 21, 22, 23, 1958	San Jose	Vernon Cheadle
11th	January 20, 21, 22, 1959	Santa Barbara	J. T. Vedder
12th	January 19, 20, 21, 1960	Sacramento	Bruce Wade
13th	January 24, 25, 26, 1961	Fresno	Stan Strew
14th	January 23, 24, 25, 1962	San Jose	Oliver Leonard
15th	January 22, 23, 24, 1963	Santa Barbara	Charles Siebe
16th	January 21, 22, 23, 1964	Sacramento	Bill Hopkins
17th	January 19, 20, 21, 1965	Fresno	Jim Dewlen
18th	January 18, 19, 20, 1966	San Jose	Norman Akesson
19th	January 24, 25, 26, 1967	San Diego	Cecil Pratt
20th	January 22, 23, 24, 1968	Sacramento	Warren Johnson
21st	January 20, 21, 22, 1969	Fresno	Floyd Holmes
22nd	January 19, 20, 21, 1970	Anaheim	Vince Schweers
23rd	January 18, 19, 20, 1971	Sacramento	Dell Clark
24th	January 16, 17, 18, 19, 1972	Fresno	Bryant Washburn
25th	January 15, 16, 17, 1973	Anaheim	Howard Rhoads
26th	January 21, 22, 23, 24, 1974	Sacramento	Tom Fuller
27th	January 20, 21, 22, 1975	Fresno	Dick Fosse
28th	January 19, 20, 21, 1976	San Diego	Jim McHenry
29th	January 17, 18, 19, 1977	Sacramento	Les Sonder
30th	January 16, 17, 18, 1978	Monterey	Floyd Colbert
31st	January 15, 16, 17, 18, 1979	Los Angeles	Harry Agamalian
32nd	January 21, 22, 23, 24, 1980	Sacramento	Conrad Schilling
33rd	January 19, 20, 21, 22, 1981	Monterey	Lee Van Deren
34th	January 18, 19, 20, 21, 1982	San Diego	Dave Bayer
35th	January 17, 18, 19, 20, 1983	San Jose	Butch Kreps
36th	January 16, 17, 18, 19, 1984	Sacramento	Ed Rose
37th	January 21, 22, 23, 24, 1985	Anaheim	Hal Kempen
38th	January 27, 28, 19, 30, 1986	Fresno	Ray Ottoson
39th	January 26, 27, 28, 29, 1987	San Jose	Ken Dunster
40th	January 18, 19, 20, 21, 1988	Sacramento	George Gowgani
41st	January 16, 17, 18, 1989	Ontario	Ed Kurtz
42nd	January 15, 16, 17, 1990	San Jose	Dennis Stroud

CALIFORNIA WEED SCIENCE SOCIETY

Conference History

CONFERENCE	DATES HELD	LOCATION	PRESIDENT
43rd	January 21, 22, 23, 1991	Santa Barbara	Jack Orr
44th	January 20, 21, 22, 1992	Sacramento	Nate Dechoretz
45th	January 18, 19, 20, 1993	Costa Mesa	Alvin A. Baber
46th	January 17, 18, 19, 1994	San Jose	James Greil
47th	January 16, 17, 19, 1995	Santa Barbara	Nelroy Jackson
48th	January 22, 23, 24, 1996	Sacramento	Dave Cudney
49th	January 20, 21, 22, 1997	Santa Barbara	Jesse Richardson
50th	January 12, 13, 14, 1998	Monterey	Ron Vargas
51st	January 11, 12, 13, 1999	Anaheim	Scott Johnson
52nd	January 10, 11, 12, 2000	Sacramento	Steve Wright
53rd	January 8, 9, 10, 2001	Monterey	Matt Ehlhardt
54th	January 14, 15, 16, 2002	San Jose	Lars Anderson
55th	January 20, 21, 22, 2003	Santa Barbara	Bruce Kidd
56th	January 12, 13, 14, 2004	Sacramento	Pam Geisel
57th	January 10, 11, 12, 2005	Monterey	Debra Keenan
58th	January 16, 17, 18 2006	Ventura	L. Robert Leavitt
59th	January 8, 9, 10, 2007	San Diego	Deb Shatley
60th	January 28, 29, 30, 2008	Monterey	Carl Bell
61st	January 28, 29, 30, 2009	Sacramento	Stephen Colbert
62nd	January 11. 12. 13 2010	Visalia	Stephen Colbert
63rd	January 19, 20, 21, 2011	Monterey	Dave Cheetham
64th	January 23, 24, 25 2012	Santa Barbara	Michelle Le Strange
65th	January 23, 24, 25 2013	Sacramento	Chuck Synold
66th	January 22, 23, 24 2014	Monterey	Steve Fennimore
67th	January 21, 22, 23, 2015	Santa Barbara	Rick Miller
68th	January 13, 14, 15, 2016	Sacramento	John Roncoroni
69th	January 18, 19, 20, 2017	Monterey	Katherine Walker
70th	January 24, 25, 26, 2018	Santa Barbara	Maryam Khosravifard
71st	January 23, 24, 25, 2019	Sacramento	Joseph Vassios