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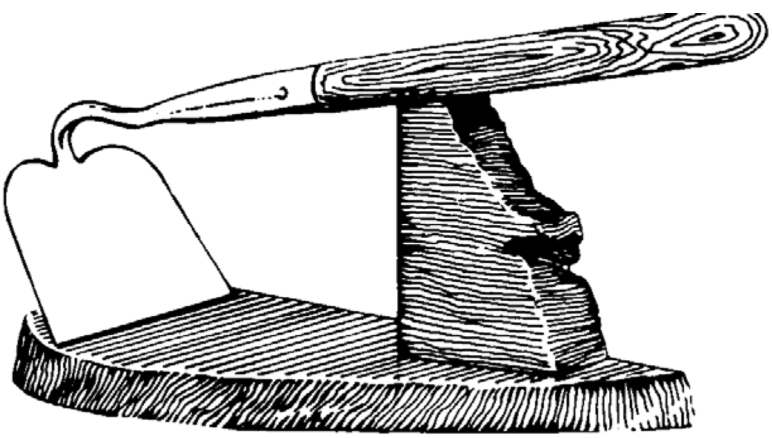
CALIFORNIA WEED SCIENCE SOCIETY

“Weed Management in a Changing Agricultural/Urban Environment”

PORTOLA HOTEL & SPA
Monterey, California

January 18, 19, & 20, 2017



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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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STEVE WRIGHT - PRESIDENTIAL AWARD FOR LIFETIME ACHIEVEMENT IN WEED SCIENCE
(presented by Past President John Roncoroni)

The Presidential Award for Lifetime Achievement in Weed Science has been awarded to Steve Wright. Steve is a Farm Advisor at the University of California Cooperative Extension, Tulare & Kings Counties, producing approximately 200,000 acres of cotton, and 200,000 acres of small grains. He conducts a regionally Extension education and research program in cotton, cereal crops, and weed control, and has done extensive weed research in cotton, cereals, trees, vines, range, and ditch banks focusing on difficult to control weeds. He is a Past President and Honorary member of California Weed Science Society.

Steve received both a B.S. and M.S. in Agronomy at California State University, Fresno. A past instructor in the Plant Science Department, he taught the "Cereal Crops", "Weeds", and “Agronomy” courses.

During 1975 to 1978, Steve served as an Agronomist-Peace Corps Volunteer at the Institute of Science, Technology & Agriculture (ICTA), Labor Orvalle, Quetzaltenango, Guatemala. Working out of a Guatemalan crop research station, he conducted a research and extension program in corn, wheat, and potatoes.

An active volunteer, Steve has helped set up a fertilizer loan program in Copper Canyon, Mexico for 60 families. He has advised on agronomy or given classes in Thailand, Uzbekistan, and Peru and is working with farmers in Myanmar, Laos, and Nicaragua. He coordinated building and currently manages four soccer fields at Neighborhood Church in Visalia, used for CYSA competitive youth soccer.

Steve Orloff - CWSS 2017 Honorary Member
(presented by Past President John Roncoroni)

Steve earned both a B.S. and M.S. in Agronomy at California State University, Fresno. He started his career with UC Cooperative Extension in the high desert of Southern California where he was a Farm Advisor for 8 years. He currently is a Farm Advisor in Siskiyou County and County Director in Siskiyou and Modoc Counties. Steve has been a general Plant Science Advisor, but weed management has always been an integral component of his extension program. While working in the high desert, his primary weed control accomplishments were the development of a sequential herbicide program for effective weed control in onions and a comprehensive program for dodder control in alfalfa using preemergence applications of dinitroaniline herbicides and post-attachment control measures. These projects and others led to Steve receiving the Award of Excellence from the CWSS in 1987. His most noteworthy achievements in weed control after moving to Siskiyou County include research on yellow starthistle, weed control in seedling alfalfa, evaluation of the Roundup Ready system in alfalfa, and most recently the discovery of injury to Roundup Ready alfalfa from glyphosate. Steve has served as Session Chair for the Agronomic Crops session at the CWSS annual conference numerous times. In addition, he has served on the CWSS Board twice, once as an Executive Board member and more recently as the Non-Conference Education Director where he served as Editor of the CWSS Research Update and News. Steve was a contributing author to the CWSS textbook Principles of Weed Control and is a regular presenter at this Conference giving over 12 presentations, and collaborating on several others over his career.

Judy Letterman - CWSS 2017 Honorary Member
(presented by Past President John Roncoroni)

Judy graduated from Cal Poly San Luis Obispo in 1977 with a crop science degree in Agronomy. Judy spent the next 10 years working for several pesticide manufacturers; Elanco (now known as Dow) in Mississippi, Chevron (now known as Valent) in the Oxnard and Santa Maria areas, and Coastal Ag Chem (now known as Crop Production Services). In 1989 Judy went to work for Hartnell College and worked with Robert Kennedy on tracking PCA hours and helping Pesticide Applicators Professional Association (PAPA) with northern California seminars. Judy began working part time for PAPA and Hartnell College in 1991, and in 1993 was employed by PAPA full time as a seminar coordinator. In 1997 Judy became the CEO of PAPA and during this time the California Weed Science Society contracted with PAPA to become their business manager. Several other associations also contracted with PAPA during this time to assist with other duties.

On December 31, 2016, Judy officially retired from PAPA and is now working as a volunteer with the California International Air Show in Salinas, enjoying her family and looking forward to her new grandson and future grandchildren to come.

Student Research Paper Awards

(Presented by CWSS Student Liaison Director, Scott Oneto)

($500) Tara Randall, Department of Biological and Agricultural Engineering, University of California, Davis

Application of Partially Stabilized Organic Amendments to Inactivate Brassica nigra (a Weed) and Fusarium oxysporum f.sp.lactucae (a Fungal Pathogen) Using Soil Stabilization

($300) Vivian Maier, Department of Plant Science, California State University, Fresno

Dormancy Requirements of Hairy Fleabane (Conyza bonariensis) Seeds

($200) Emily Bick, University of California, Davis

Spatio-Temporal Ecological Modeling of Water Hyacinth Environment on the Performance of a Biological Control Agent

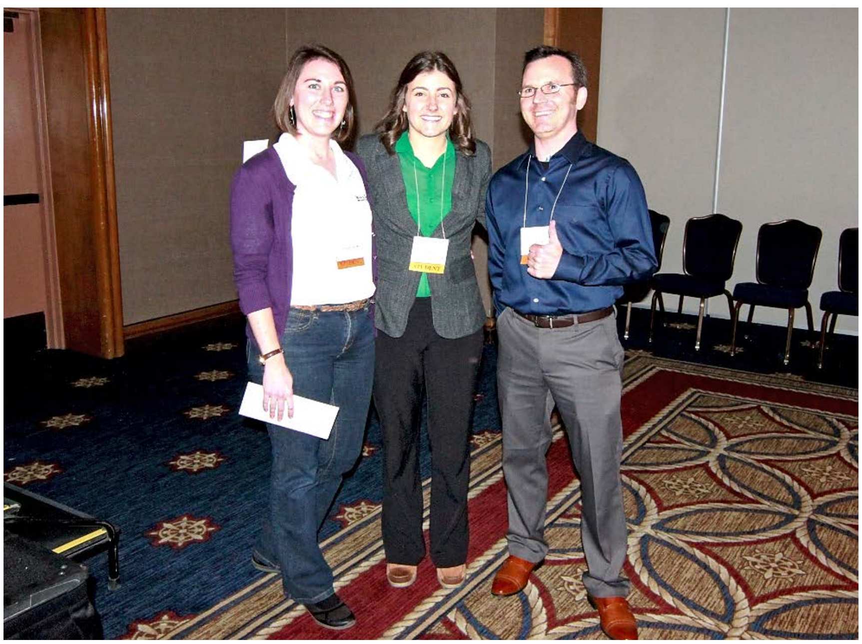
CWSS Director Scott Oneto and student paper awardees
Tara Randall, Vivian Maier and Emily Bick

Student Research Poster Awards
(Presented by CWSS Student Liaison Director, Scott Oneto)

($500) Tara Randall, Department of Biological and Agricultural Engineering, University of California, Davis
Application of Partially Stabilized Organic Amendments to Inactivate Brassica nigra (a weed) and Fusarium oxysporum f.sp.lactucae (a fungal pathogen) Using Soil Stabilization

($300) Alex Ceseski, University of California Davis
Effects of Seeding Depth on Weed Control in Drill-Seeded Rice

($200) Liberty Galvin, University of California, Davis
Temperature, Glyphosate Interactions within Roundup Ready Alfalfa



Student poster awardees Liberty Galvin, Tara Randall and Alex Ceseski

In Memorium

Paul David Lancaster passed away August 1, 2016. He was born June 16, 1952, in Bakersfield, California. After graduation from North High School, Paul served in the United States Army in Germany, with the Pershing Missile program. He attended Cal Poly, San Luis Obispo graduating in 1977 with a degree in Crop Science, working in various ag related jobs before settling in the Tulare area in 1981, where he managed the R.A. Hildebrand Ranch. Eventually he entered education and was a beloved Science teacher at Oak Valley Union School, and Tulare Western High School. During the summers he operated his own PCA service, working with Watte & Sons and Clarklind Farms. He received his Jurist Doctorate in 2004, and served as a Tulare County Deputy District Attorney until 2007, when he entered private practice.

Paul is survived by his wife of 43 years, Terri, their three children and five grandchildren, and best friend, Dana Edson.

Leroy Franklin "Frank" Aulgur Jr., 64, passed away on November 17, 2016. Frank was born in Stockton, California on November 8, 1952 and had resided back in Arbuckle for 9 years after living in Roseville for 19 years and Manhattan, Kansas for 7 years. Frank proudly served in the U.S. Army from 1971-1973 in the 82nd Airborne Division. After an honorable discharge, he attended college and graduated with honors from Cal Poly, San Luis Obispo. He then went to work for E. I. DuPont and when DuPont sold to Bayer, he continued his career for Bayer Environmental Science for a total of 35 years. Frank was a long time contributor at the CWSS conference, both as an exhibitor and sponsor, and volunteered many times as a program session chair. He had a larger than life personality in any room he entered.

Frank loved spending time with his family as well as hunting and fishing. He also loved working in his yard and spoiling his dog and cats.

Frank is survived by his wife Linda of 37 years, son Sam of Roseville, son Jake and his fiancé Kristen of Roseville, sister Joyce Wilkins (Richard) of Yuba City, sister Bonnie Ehrke (Allen) of College City, sister Betsy Deming of Marin County, sister Ruth Hobson (Gary) of Rocklin and numerous nieces and nephews.

Gary Lee Ritenour passed away peacefully on January 10, 2017 surrounded by family. He was born on October 5, 1938 to Andrew and Treva Ritenour in Warsaw, Indiana. He graduated from Lincoln High School in Plymouth, Indiana, before obtaining his bachelor's (1960) from Purdue University, and his master's (1962) in Agronomy and doctorate (1964) in Plant Physiology from the University of California at Davis (UCD). He was the first in his family to attend college and led the way for several siblings and his two children. Both his children graduated with bachelor's degrees from California State University, Fresno (CSUF), and his son also went on to obtain a master's and doctorate from UCD, following in his father's footsteps.

Professionally, he went on to work as a postdoctoral research associate at the University of Illinois until moving to Fresno, California in 1966 to work as a Fresno county Farm Advisor for the University of California. In 1969 he acquired a position at CSUF. While there, he served in many roles as professor including director of the crop production and protection center (1986-89), chairperson of the plant science mechanized agriculture department (1989-91), and the college's director of agricultural operations (1991-97). However, he always took his greatest pleasure in working with students. He started "Turf Day" in 1973 that became "Vintage Days" at Fresno State. He retired in 1999.

Gary Ritenour was a loving husband, father and papa. His hard work, wise counsel, and compassion touched the lives of countless people and he will be greatly missed.

He is survived by his wife Margaret Ritenour, children Mark Ritenour and Connie Yee, and five grandchildren.

Glyphosate Herbicide: Separating the Fact from the Fiction. Carl K. Winter*, Food Science and Technology, University of California, Davis, CA, USA. *Corresponding author (ckwinter@ucdavis.edu)

The herbicide glyphosate has received significant public and regulatory attention following its classification by the International Agency for Research on Cancer (IARC) as a "probable human carcinogen" in March 2015. The IARC classification was part of a controversial hazard identification process and does not represent an assessment of actual human health concerns. The IARC classification has been disputed by several international government organizations including the German Federal Institution for Risk Assessment, the European Food Safety Authority, The Joint Food and Agricultural Organization of the United Nations / World Health Organization Meeting on Pesticide Residues, and the US Environmental Protection Agency. Recent studies of food consumer exposure to glyphosate indicate that the levels of glyphosate consumers are typically exposed to represent only a small fraction of levels of health significance.

Challenges of Weed Management in Urban Areas. Chris A. Geiger, Ph.D. Toxics Reduction and Healthy Ecosystems Program, San Francisco Department of the Environment, San Francisco, CA. chris.geiger@sfgov.org

Effective weed management efforts in major urban centers require more than the latest research findings or cost analyses. Particularly in cities with a politically involved citizenry, weed control actions may also involve public education, risk communication, citizen involvement, and navigating political processes in addition to simply meeting land management goals. Action thresholds in urban weed management differ from agricultural situations in that they are not tied to economic losses; instead, they are tied to public safety, public health, environmental, operational and aesthetic factors. These unquantifiable factors further complicate the task of landscape managers. In this presentation, the speaker will tell the story of San Francisco's recent weed management efforts, with emphasis on public processes underway since 2015, when the International Agency for Research on Cancer (IARC) reclassified glyphosate as a Probable Carcinogen. In these processes, conflicting community values over biodiversity and pesticide risks have come to the fore, challenging established land management efforts, the city's Integrated Pest Management Program, and San Francisco's commitment to the Precautionary Principle.

Integrated Weed Management is Needed Now More Than Ever.

Steven A. Fennimore, University of California, Davis, at Salinas, CA
*Corresponding author email safennimore@ucdavis.edu

Nature abhors a vacuum and given the chance will fill the space. Agriculture is an ordered low stress environment designed to maximize crop production and profitability. Maintenance of this ordered low stress environment in a crop field requires work (energy) to maintain because the field is not at equilibrium with its environment. The work that goes into maintaining this weed free field is familiar to us, and consists of weed control tools like crop rotation, prevention of weed seed production, stale seedbeds, physical weed control like cultivation and hand weeding, and herbicides. Used in combination, these tools will reliably manage most weeds.

There are several challenges to weed management that we are faced with: 1. Permanent crops like trees and vines are not rotated from year to year so crop rotation is not feasible; 2. New herbicides are few in number today compared with the 1960s' 70s and 80s, so we must make the best use of existing products; 3. Costs are high and profit margins are narrow requiring efficient cost-effective weed management methods; 4. Labor costs are increasing and supply is shrinking thus hand weeding is becoming less feasible as time goes by.

The more variation and flexibility in our weed management system the more likely that it will always work. By rotating crops, preventing weeds from going to seed, performing mechanical cultivation, hand weeding and varying our herbicide program we will probably have a successful weed management program. If we always use the same herbicide because it is cheap and easy, if we start dropping tools from our weed management program like cultivation and hand weeding, if we let weeds go to seed because we don't have the time or money to control them, then we will most likely not have a successful weed control program. There is a limit as to how many shortcuts we can take with weed management programs. If we keep using the same herbicides repeatedly, and use a spray only program, then weed resistance to the herbicides will likely result. New herbicide mechanisms would help avoid weed resistance, but no new mechanism of action has been introduced in over 25 years.

We need to develop new weed management programs that utilize as many of our existing tools as possible in an integrated fashion. We also need to pay attention to new technology – specifically robotics. There are already robotic cultivators commercially available that mimic the activities of hand weeing crews by removing weeds with cultivator knives or spray solutions. These new robotic tools can be combined with existing tools to create a successful weed management system. There is no one answer to creating a successful integrated weed management system for all crops and environments. We will need to evaluate each situation separately and find the best IWM system for that situation. We need to respect the need for variation in our choice of weed management tools. Weeds are very adaptable and if we give them an opening there will be a weed species or biotype that can successfully exploit the opening. Nature abhors a vacuum and if there is a leak in the system, weeds will exploit it.

Application of Partially Stabilized Organic Amendments to Inactivate *Brassica nigra* (a Weed) and *Fusarium oxysporum f.sp.lactucae* (a Fungal Pathogen) Using Soil Biosolarization. J.D. Fernández-Bayo[1,2], T.E. Randall*[2], Y. Achmon[1,2], K.V. Hestmark[2], D.R. Harrold[2], J.Su[1], R.M. Dahlquist-Willard[3], T.R. Gordon[4], J.J. Stapleton[5], J.S. VanderGheynst[2], and C.W. Simmons[1]. [1]Department of Food Science and Technology, University of California, Davis, CA, USA (UC Davis), [2]Department of Biological and Agricultural Engineering, UC Davis, [3]University of California Cooperative Extension, Fresno County, CA, USA, [4]Department of Plant Pathology, UC Davis, [5]Statewide Integrated Pest Management Program, University of California, Kearney Agricultural Research and Extension Center, Parlier, CA, USA.

Composting is a widely used conversion practice for organic waste management and compost products are often applied as soil amendments due to their positive impact on soil quality. Anaerobic digestion (AD) is becoming an increasingly popular organic waste conversion process due to the potential to produce renewable biofuel as a value-added product from the waste. The by-products of AD are known as digestates, and their beneficial effects as soil amendments are currently being researched. Soil biosolarization (SBS) is an enhanced soil disinfestation process, achieved by amending soil with organic matter prior to solarization. The efficacy of SBS has been shown to be influenced by the biological stability of the organic amendments. As a result, the application of compost and digestate in SBS may be limited by the high degree of stability of these materials in their mature form. The objective of this study was to assess the impact of partially stabilized organic matter on soil biosolarization. The organic soil amendments selected for this study were derived from green and food wastes that were partially composted (PC) and partially digested. The partially digested feedstock was separated into solid digestate (SD) and liquid digestate (LD). To assess the impact of these amendments on SBS, the inactivation of two target pests was monitored. Mesocosms were loaded with a sandy clay loam soil, either non-amended or amended with the three types of feedstocks. Furthermore, the experimental plot was deliberately infested with *Fusarium oxysporum f.sp.lactucae* (FOL), a fungus causing lettuce disease. Weed seeds of *Brassica nigra* were placed at 12.5 cm depth. The mesocosms were solarized in an experimental plot or incubated at room temperature (RT, 25ºC) for eight days. Solarization of the non-amended soil increased weed seed mortality from 9.07±5.92% at RT to 18.44±7.69%. In the amended samples the mortality increased from 3.35±3.33%, 2.66±3.65% and 5.35±5.04 at room temperature to 34.05±7.94%, 33.18±15.37% and 34.15±18.21% for the soil amended with PC, SD and LD, respectively. At 5 cm, solarization reduced FOL in the non-amended soil from 275±99.25 colony forming units (CFU)/g of soil to 27.78±34.00 CFU/g. In all the amended samples FOL levels were below the detection limit (<20.8 CFU/g) at this depth. At 12.5 cm, the levels of FOL were 100±88.88 CFU/g in the solarized, non-amended soil and 41.66±20.85, 49.98±27.96 and 83.34±60.04 CFU/g for the solarized soils amended with PC, SD and LD, respectively. Although complete inactivation was not achieved after 8 days (current treatment guidelines are 4-6 weeks of heating), results show promising impacts of biosolarization with these amendments for inactivation of both studied pests. Further research is needed to understand the mechanisms

involved in inactivation. Special focus is needed on volatile fatty acid (VFA) accumulation as VFAs have previously been shown to contribute to pest inactivation.

Spatio-Temporal Ecological Modeling of Water Hyacinth Environment on the Performance of a Biological Control Agent. Emily Bick*, UC Davis, enbick@ucdavis.edu; Christian Nansen, UC Davis, chrnansen@ucdavis.edu

To investigate the mechanisms of water hyacinth (Eichhornia crassipes) control, an efficient Baysian model system is required. Although deterministic models have been used to predict organism control, such models suffer from the inability to account for stochasticity in a system Entomologists and conservationists in related fields have offered multidisciplinary and multi-institutional computer modeling programs to optimize success of biological control agents. In view of the success of such models, it was decided to provide an up to date and comprehensive spatio-temporal ecological model of water hyacinth environment on the performance of a biological control agent. The first section of this presentation details the selection of the salient variables for spatio-temporal ecological models. The second section contains information dealing with biological control (Coleoptera: Curculionidae Neochetina bruchi) and weed interactions. The third section provides the results of a test of the model.

Keywords: Water Hyacinth, Neochetina bruchi, spatio-temporal modeling

Dormancy Requirements of Hairy Fleabane (*Conyza bonariensis*) Seeds.

Vivian Maier and Anil Shrestha, Department of Plant Science, California State University, Fresno, CA 93740

Hairy fleabane (*Conyza bonariensis* L. Cronq.) is considered a summer annual weed in California. However, it is often seen to be growing year round in the Central Valley. This is primarily because there are two major periods of germination of this species in the Central Valley. It either germinates and emerges in fall, over-winters as a rosette, and completes its life cycle in early summer or it germinates and emerges in late winter and completes its life cycle in late summer or early fall (Shrestha et al. 2008). This species is known to produce as many as 226,000 seeds per plant (Kempen and Graf 1981). Although the optimal temperature of seed germination for this species ranges between 65º to 75º F, it has been reported to germinate at temperatures as low as 39.5° F (Wu et al. 2007). The seeds are also reported to be able to germinate under moderate water stress of up to -0.4 MPa (Karlsson and Milberg 2007). This species, similar to horseweed, is primarily a surface germinating type, i.e. its germination is reduced when buried more than 1 mm deep. Although much information is available on germination ecology of horseweed (*C. canadensis* L. Cronq.), very limited information is available for hairy fleabane. For example, it has been suspected that its seeds may not have a long dormancy period for germination. Therefore, the objectives of this study were to determine the dormancy and moisture requirement of hairy fleabane seeds for germination.

A study was conducted in Fresno, CA in 2016 in a lab under room temperature of 72º F and ambient light conditions. Seeds of hairy fleabane plants were collected from vineyards in Fresno. Seeds of five random plants were collected and bagged separately. Twenty five seeds from each hairy fleabane plant were placed on Whatman No. 1 filter papers placed in separate 100 by 15 mm Petri dishes. Ten ml deionized water was added to each petri dish with a pipette. The seeds were tested for germination, a) the day they were harvested, b) one week after they were harvested, c) two weeks after they were harvested, and d) three weeks after they were harvested. The petri dishes were periodically examined for germination till the process ceased. A seed was considered to have germinated if they had a 1 mm long radicle and plumule. The experiment was arranged as completely randomized design where the different days after harvest were the treatments and each plant was a replicate.

Another study was conducted to determine the level of tolerance to moisture stress during germination. The study was also conducted in the same lab under similar environmental conditions. Solutions of various water potentials (0, -0.149, -0.51, -1.09, -1.88, -2.89, -4.12, and -5.56 MPa) were prepared using polyethylene glycol (PEG 6000; Fisher Scientific, Houston, TX). Twenty seeds from each hairy fleabane plant were placed on Whatman No. 1 filter paper placed in separate 100 by 15 mm Petri dishes. Ten ml of the different ψ solutions were added to each Petri dish with a pipette. The Petri dishes were then sealed with parafilm (Parafilm M™ Wrapping Film, Fisher Scientific, Houston, TX). Germination was monitored as described above. Total germination at 0 MPa was considered 100% and the percent germination in the other treatments were calculated relative to germination at 0 MPa. The experimental set up was a completely randomized design where each plant was a replicate. The experiment was repeated. Data for both experiments were analyzed using analysis of variance procedures and the means were separated by Fisher's least significant difference process at a 0.05 level of significance. A non-linear regression was also fit to the data on moisture stress.

More than 54% of the seeds that were put in the petri dishes the day they were harvested germinated; although, the germination percentage was significantly lower than the other treatments. Total germination in the other treatments ranged between 68% to 72% and there were no significant differences between the treatments in total germination percentage of the seeds. In the moisture-stress study, up to 71% of the seeds germinated at – 0.149 MPa, a few (approximately 10%) seeds germinated at -0.51 MPa but none of the seeds germinated in the other treatments. The non-linear regression estimated that the water potential to reduce germination by 50% was approximately -0.28 MPa.

This study showed that hairy fleabane seeds could germinate the day they fall off from the mother plants. However, they need adequate moisture to germinate and it is not very drought-tolerant in terms of seed germination compared to several other weed species.

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Response of Walnuts to Simulated Drift of Rice Herbicides.

Mariano Galla, University of California, Davis. Email: mfgalla@ucdavis.edu

English walnut is one of the top commodities grown in California and its importance has been increasing in the last decade, with a gross dollar value of $1.36 billion in 2012. In the Sacramento Valley, walnut orchards often are in close proximity to rice fields. Therefore, herbicide applied to rice may drift on walnuts and cause injury. The majority of rice herbicide applications are made by airplane between the end of May and early July. This time frame coincides with a period of rapid growth for walnut trees as well as flower bud initiation for the subsequent year's crop. Two simulated herbicide drift field studies were established at the UC Davis research station to evaluate the symptoms and growth effects of rice herbicides on young walnut trees. In the first study, the effect of three commonly used rice herbicides were studied: bispyribac, bensulfuron and propanil. Each herbicide was applied at four simulated drift rates: 0.5%, 1%, 3% and 10% of the high use rate in rice (44.8, 70.2, and 6725.1 g ai/ha for bispyribac, bensulfuron and propanil, respectively). All three herbicides caused significant damage and delayed growth of young walnut leaves and shoots with the maximum symptoms observed 28 days after treatment. At one month after treatments, walnuts started recovering, although symptoms were still evident in late October. In a separate study, bispyribac was applied four times at weekly intervals at two different rates: 0.5% and 3% of the rice use rate. Bispyribac-sodium, at both rates, caused significant symptoms to walnuts leaves and growth delay of young shoots. Symptoms were still readily observed in late October, more than four months after the last simulated drift event. The effects of these treatments on walnut yield and quality are being evaluated in ongoing experiments.

Palmer Amaranth (*Amaranthus palmeri*) Management Issues in California.

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Palmer amaranth (*Amaranthus palmeri*) has been ranked as the most troublesome weed in the U.S. by the Weed Science Society of America, based on a national survey. Widespread glyphosate-escapes of Palmer amaranth were reported in various annual and perennial cropping systems beginning in 2012 in the San Joaquin Valley (SJV) of California. In 2013/14, 25 field collected populations from the SJV were screened for resistance in greenhouse studies. The plants were tested for glyphosate resistance by making an application of a label rate of glyphosate (22 fl oz/ac of glyphosate) + 2% v/v solution of ammonium sulfate with a spray volume of 20 gallons/ac (GPA) on 5- to 8-leaf stage Palmer amaranth plants grown in pots. Plant mortality was rated 21 days after treatment (DAT) and compared to a confirmed glyphosate-resistant (GR) population from New Mexico. An untreated control treatment was also included. Glyphosate resistance was not observed in the SJV population in these initial studies.

Further experiments were conducted to compare the mortality of one of the SJV population to label rates of glyphosate, glufosinate, paraquat dichloride, saflufenacil, rimsulfuron, and a tank-mix of glyphosate + saflufenacil applied at the 4- to 6-, 8- to 10-, and 12- to 16-leaf stages (Rios et al, 2016). Complete control of Palmer amaranth was obtained with all treatments when applied at the 4- to 6-leaf stage but control was reduced with glyphosate and glufosinate at larger growth stages (Figure 1). The other treatments provided excellent control at all growth stages tested.

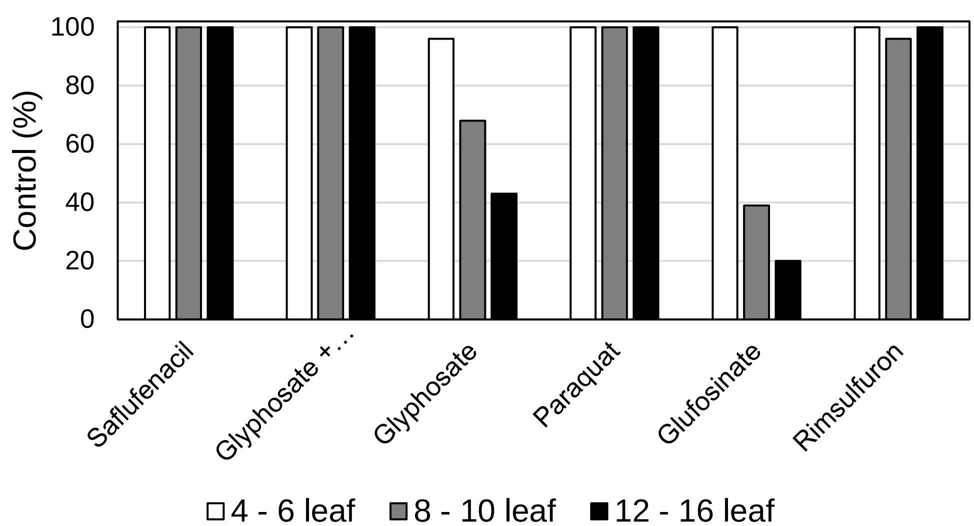

Figure 1. Mortality (% control) of Palmer amaranth plants treated with various herbicides at the 4- to 6-, 8- to 10-, and 12- to 16- leaf growth stages.

Tank-mix combinations (Table 1) of saflufenacil + glyphosate, saflufenacil + glufosinate, saflufenacil + dicamba, rimsulfuron + glyphosate, tembotrione + glyphosate, flumioxazin + pyroxasulfone + glyphosate, flumioxazin + pyroxasulfone + glyphosate, dicamba + paraquat dichloride, and glyphosate + glufosinate were also tested on 8- to 10-leaf stage Palmer amaranth plants and all the combinations provided excellent control (Rios et al. 2016).

Table 1. Mortality of Palmer amaranth plants 28 days after treatment at the 8- to 10-leaf stage with different herbicides.

Treatment[a]	Rate/acre	Plant mortality
		%
Saflufenacil + Glyphosate	1 oz + 22 fl oz	100
Saflufenacil + Glufosinate	1 oz + 29 fl oz	100
Saflufenacil + Dicamba	1 oz + 12 fl oz	100
Rimsulfuron + Glyphosate	4 oz + 22 fl oz	100
Tembotrione + Glyphosate	3 fl oz + 22 fl oz	100
(Flumioxazin + Pyroxasulfone) + Glyphosate	3 oz + 22 fl oz	100
(Flumioxazin + Pyroxasulfone) + Glufosinate	3 oz + 22 fl oz	100
(Flumioxazin + Pyroxasulfone) + Dicamba	3 oz + 12 fl oz	100
Dicamba + Paraquat	12 fl oz + 32 fl oz	100
Glufosinate + Glyphosate	20 fl oz + 22 fl oz	100

Glyphosate resistance screenings were continued on additional populations of Palmer amaranth collected from various locations in the SJV. In the process, in 2015, Palmer amaranth plants were collected from a Roundup Ready corn field in the Hilmar area of the SJV and grown to maturity in a greenhouse. Seeds produced from these plants were collected. In summer 2016, plants produced from these seeds were grown and tested for glyphosate resistance by comparing to a confirmed GR population from Tennessee and a glyphosate-susceptible (GS) population from Fresno, CA. Plants at the 4- to 6-leaf stage were sprayed with glyphosate at 0, 11, 22, 44, 88, and 176 fl oz/ac at a spray volume of 20 GPA with CO_2 backpack sprayer. Plants were periodically evaluated for mortality up to 28 DAT. At 28 DAT, the plants were clipped at the soil surface and the aboveground biomass was put in paper bags, dried in a forced-air oven at 140°F for 72 hours and dry weights were recorded. Treatments were replicated six times for each population and the experiment was repeated. About 60% of both the GR population from TN and the suspected GR population from CA survived up to the 176 fl oz/ac treatment; whereas none of the GS plants survived any of the treatments greater than 11 fl oz/ac (Figure 2). However, the biomass of the suspected-resistant plants from CA and GR plants from TN was reduced by 50% at 22 fl oz/ac compared to the control treatment. Based on mortality the suspected-resistant plants from CA showed about 8-fold resistance to glyphosate. This is the first confirmed case of GR Palmer amaranth in California.

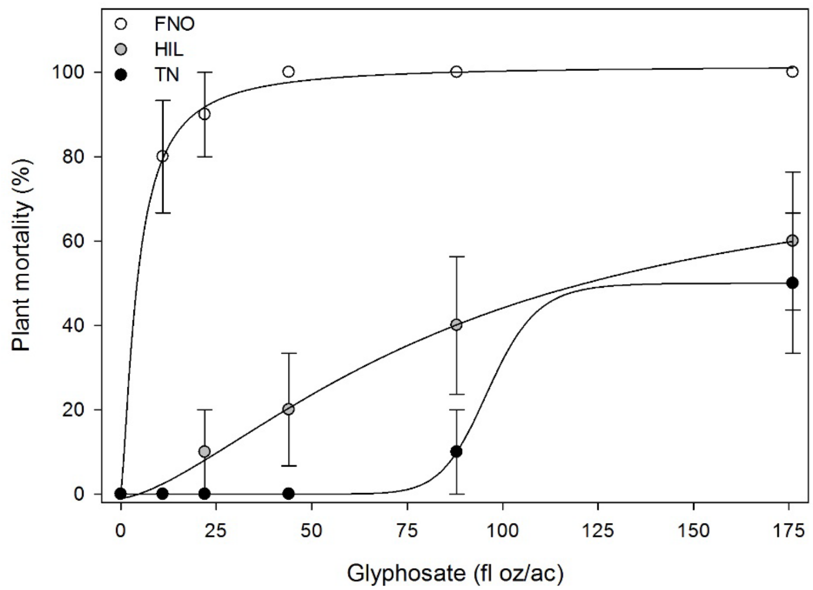

Figure 2. Mortality (% control) of Palmer amaranth plants from Fresno (FNO) and Hilmar (HIL), CA and a confirmed GR population from Tennessee (TN) treated with various rates of glyphosate at the 4- to 6-leaf growth stages.

Therefore, GR populations of Palmer amaranth exist currently in the SJV. If growers suspect that they still have GS populations of Palmer amaranth in their fields and desire to control them with glyphosate- or glufosinate-alone then applications should be made by the 6-leaf stage. If control with glyphosate at this growth stage is not satisfactory and glyphosate resistance is suspected, then other herbicides, or tank-mix combinations of herbicides, or other weed control methods should be used for immediate removal of these populations and prevention of seed set. Nevertheless, an integrated weed management strategy has to be adopted for successful control of Palmer amaranth to prevent it from being more problematic than it already is.

References:

Rios, S., S. D. Wright, G. Banuelos, and A. Shrestha. 2016. Tolerance of *Amaranthus palmeri* populations from California to postemergence herbicides at various growth stages. Crop Prot. 87:6-12.

Sharp-point Fluvellin: The Creeping Menace. John Roncoroni, University of California Cooperative Extension, Napa, CA

Sharppoint fluvellin [Kickxia eglantine(L.) Dumort.); and the family: Scrophulariaceae, has gone from what many growers considered a minor nuisance in the northern Napa and eastern Sonoma counties, to a weed that has exploded throughout the state. In some areas the infestations of this annual weed have become so thick that when the plant dies in the winter it leaves a ‘skeleton’ that catches fallen grape leaves. This barrier keeps herbicides from hitting the soil and may ‘protect’ small weeds from being hit by postemergence herbicide making the application ineffective.

This presentation summarizes several trials over a period of 9 years that describe the biology and control methods for fluvellin. We are just beginning to understand fluvellin biology as it relates to its growth in vineyards in northern California. Germination can occur throughout the year, except for the coldest part of winter. Germination that occurs in mid to late summer and throughout the fall is the most important. Vineyards that are routinely cultivated in the vine row will not have a large fluvellin problem. It is the vineyards that are ‘no-till’ under vine that may see large infestations of fluvellin.

Results: Fluvellin is not a ‘good competitor’, meaning that is less of a problem when weed control is not as effective against other weeds. In fact, in one trial fluellin was controlled very well in the Untreated Control plot. All other treatments included glyphosate which killed the grass and other weeds that were competing with the fluvellin. Long-lasting herbicides are important for fluvellin control because of its extended, late germination period. Trial results indicate that a postemergence treatment with glyphosate after leaf drop in late fall or early winter combined with a treatment in late winter(but before bud break) made up of a combination of glyphosate plus a burn-down herbicide plus a long lasting preemergence herbicide provides the best control of fluellin.

Paraquat-resistant Italian Ryegrass Management Options in Orchard Crops in California. Caio Brunharo[1], Bradley D. Hanson[2]. [1]PhD Student, UC Davis; [2]UCCE Weed Science Specialist, UC Davis. *Corresponding author (cabrunharo@ucdavis.edu)

Italian ryegrass (*Lolium perenne* L. *spp. multiflorum* (Lam.) Husnot) is a worldwide weedy species and its infestation causes yield losses in a variety of cropping systems. Selection pressure imposed by repeated herbicide use has selected Italian ryegrass populations resistant to several herbicide mode of actions across the world. Recently, poor control of Italian ryegrass with paraquat was reported by orchard managers near Hamilton City, California. We hypothesize that, if paraquat selection pressure was applied on an already glyphosate-resistant population of Italian ryegrass, then the low paraquat efficacy may be due to the selection of a multiple-resistant biotype. In this context, greenhouse dose-response, field and laboratorial experiments were carried out to evaluate Italian ryegrass response to several PRE and POST herbicides and the mechanism that confers resistance to paraquat in this biotype. A susceptible Italian ryegrass biotype from an internal collection (S) and a suspected paraquat-resistant population (PRHC) from a prune orchard near Hamilton City, were used. Greenhouse dose-response treatments were applied using a spray chamber calibrated to deliver 20 GPA when plants were 4 inches tall in the Fall 2015. Clethodim, fluazifop, glufosinate, glyphosate, mesosulfuron, paraquat, pyroxsulam, rimsulfuron and sethoxydim were applied at seven fractional rates ranging from 0.125 to 8 times their field rate plus an untreated control, in order to model Italian ryegrass response and calculate resistance parameters. Aboveground biomass was collected at 28 DAT and used to develop log-logistic models and determine the resistance index (RI = GR_{50R}/GR_{50R}). A field experiment containing 15 POST treatments was carried in the prune orchard near Hamilton City. Treatments were applied in May 2015 when the ryegrass was 10 inches tall. Visual evaluations were carried out at 7, 14, 21 and 28 days after treatment, based on a 0-100 scale, where 0 represents no visible injury and 100 represents complete plant death. Preemergence herbicides commonly used in orchards in California were also tested for control of PRHC. Treatments were applied in Fall 2015, and visual assessments were carried out every 30 days up to 150 days after treatment (DAT). In the laboratory, the absorption and translocation of ^{14}C-paraquat was quantified, and the possibility of paraquat metabolism in the resistant and susceptible biotypes was evaluated using HPLC-based analytical techniques. Greenhouse results indicated that PRHC had high RI when treated with paraquat and sethoxydim, and moderate RI when treated with clethodim, glyphosate and pyroxsulam. A low RI was obtained with mesosulfuron. The POST field experiment corroborates with data from the greenhouse studies, since control of PRHC with glyphosate and paraquat were the least efficient. On the other hand, most of the treatments containing glufosinate were effective for control of the resistant population. From the PRE field experiment, all treatments containing indaziflam controlled PRHC up to 150 DAT. Combinations of flumioxazin, flumioxazin + pendimethalin, flumioxazin + oryzalin, oryzalin, oxyfluorfen and pendimethalin exhibited control percentages above 90% up to 150 DAT. Although PRHC exhibited a slower ^{14}C-paraquat absorption, the maximum absorption was similar compared to the S biotype. However, under light-manipulated laboratory conditions, PRHC exhibited reduced translocation of ^{14}C-paraquat, where most of the herbicide was retained in the treated leaf. In summary, PRHC presents multiple resistance to ACCase-inhibitors, ALS-inhibitors, EPSPS inhibitors and PSI inhibitors; tankmixes containing

glufosinate control PRHC even at advanced plant developmental stages; several PRE herbicides may be used to control PRHC; and limited movement of ^{14}C-paraquat was observed in PRHC.

Environmental and Soil Factors Influencing Pre-emergent Herbicide Activity.

Matt Ehlhardt,Tremont and Lyman Groups

Observations were made on the influence of delayed rainfall for pre-emergence incorporation as well as the level or type of debris or trash on the orchard floor and its effect on pre-emergence herbicide activity. Pre-emergence herbicides applied to a tree fruit, nut or vine crop must be incorporated through rainfall or irrigation in order to be absorbed by the germinating seed, or developing root or shoot. Without incorporation, left on the soil surface for an extended period of time can lead to the eventual degradation of that product. Herbicide labels have specific instructions or warnings for the duration of time before and usually how much rainfall or irrigation is needed for incorporation before the chemical will begin to degrade. From 2011 through 2015 our fall and winter rains were erratic and at times too low to meet the label suggestions for the needed rainfall. Trials established during periods of low rainfall helped us understand that even during these reduced rainfall periods as long as some level of moisture was obtained the products were able to provide partial control across species and that when tank mixed (different modes of action) control across all species in the field was usually obtained. Differences in control during periods of reduced rainfall were noted in different soil types. Improved weed control was seen in clay loam soils versus sandy loam soils where only specific tank mixes provided uniform control across species. In clay loam soils Matrix, Chateau or a tank mix of the two gave excellent weed control despite not having the required rainfall in a timely period. In a lighter sandy loam soil Alion + Pindar GT or Chateau + Matrix were needed to provide control across all species rated in the trial. In the sandy loam soils we noted a reduction in Alion's ability to control panicle willowherb, a weed which it normally controls easily. At this site Alion controlled the shallow germinating weed seeds, fleabane and red stem filaree, but we feel that with the herbicides low water solubility and reduced rainfall it was not incorporated to a sufficient depth to be absorbed by the germinating panicle willowherb. Finally we also made observations on the effect of debris on the orchard floor. Various trials had applications go out where it was noted that old weed carcasses did impact certain products ability to control certain weeds but not all. For instances where old bindweed carcasses were present Pindar GT provided better control of fleabane versus Alion. At another site with old fluvellin carcasses Alion or Chateau both gave good overall weed control (including fluvellin) compared to Zeus + Matrix or Goal 2 XL + Prowl H2O which did not.

Integrated, Adaptive Management of Aquatic Weeds: The USDA-ARS Delta Region Areawide Aquatic Weed Project (DRAAWP). Patrick J. Moran[1*], Paul D. Pratt[1], David L. Bubenheim[2], Christopher Potter[2], Sharon P. Lawler[3], Karen C. Jetter[4], Edward J. Hard[5], Beckye Stanton[6], [1]U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS), Exotic and Invasive Weeds Research Unit (EIWRU), 800 Buchanan St., Albany, CA 94710, USA, [2]National Aeronautics and Space Administration (NASA), Ames Research Center, Moffett Field, CA, USA, [3]University of California-Davis, Department of Entomology and Nematology, Davis, CA, USA, [4]University of California-Davis, Department of Agricultural and Natural Resource Economics, Agricultural Issues Center, Davis, CA, USA, [5]Division of Boating and Waterways, California Department of Parks and Recreation, Sacramento, CA, USA, [6]Sacramento-San Joaquin Delta Conservancy, Sacramento, CA, USA. *Corresponding author (Patrick.Moran@ars.usda.gov)

The Sacramento-San Joaquin Delta is the critical nexus of California's scarce water supply. The Delta provides part or all of the drinking water for 25 million people and irrigates 4 million acres of cropland producing $25 billion annually. The Delta is also home to one of the state's largest recreational boating industries and supports large-scale commercial navigation for import/export shipments. Finally, the Delta provides habitat for threatened and endangered fish and a wide range of plant and animal life. Invasions by aquatic weeds, especially water hyacinth (*Eichhornia crassipes*), Brazilian waterweed (*Egeria densa*), and the shoreline giant grass invader known as arundo (*Arundo donax*), have required annual expenditures of over $5 million per year to control, but continue to exert damaging impacts by impeding water conveyance to agricultural, industrial and domestic users, obstructing recreational and commercial navigation, altering water quality, and degrading natural habitats in the Delta. The USDA-Agricultural Research Service initiated support for a new Delta Region Areawide Aquatic Weed Project (DRAAWP) in 2014. The project is using new tools to detect and control invasive aquatic weeds, and is bringing agencies involved in aquatic weed control and management of water resources together to share knowledge and leverage resources to implement integrated, adaptive management. Under the strategic direction of the implementation component of the project, selecting focus impact areas for increased chemical and mechanical control treatments, water hyacinth peak annual coverage in the Delta has been reduced markedly since 2014, as detected using satellite images. New chemical and mechanical control regimes are being tested at key sites that are most critical for water conveyance and navigation. One new biocontrol agent, a planthopper, is being released, and mechanisms to improve efficacy of two previously released weevil species are being investigated. Decision support tools for water hyacinth control are being developed by incorporating new information on water hyacinth responses to altered environments and impacts on growth, new remote-sensing derived knowledge of the seasonal distribution of this aquatic weed, and interagency dialogue to identify the sites that are most critical for water resource management. Brazilian water weed control has improved over two-fold with no increase in the amount of chemicals used, as a result of an improved application regimen. Chemical and bio-chemical integrated control of arundo is being implemented. Two biological control agents that are new to this region are being released, a pilot project with herbicide treatment is underway, and new inter-agency dialogue is being used to facilitate site access. Under an assessment component of the

DRAAWP, new control tools are being evaluated in field plots, and new techniques are being used to evaluate operational field efficacy. A bio-economic model is measuring the costs/damage associated with the aquatic weeds and will be used to estimate the benefits of successful management. Under the research component of the project, studies in tanks and in the field have shown positive associations between decaying water hyacinth and larval mosquito populations. Other studies are determining key factors that determine aquatic weed growth, modeling the effects of agricultural land use on water quality, and examining the impact of water hyacinth and its management on dissolved water oxygen. Under an outreach component, a website has been launched, and regular meetings are keeping stakeholders informed. The overall goal of the DRAAWP is to bring about improved management of numerous aquatic weeds in the Delta through scientific knowledge and improved inter-agency cooperation.

Hydrilla Eradication Challenges, Partnerships and Lessons Learned. David Kratville, Michelle Dennis and Jonathan Heintz. California Department of Food and Agriculture, Sacramento, CA. david.kratville@cdfa.ca.gov

The California Department of Food and Agriculture (CDFA) has housed the Hydrilla Eradication Program since 1977. Detection and eradication of hydrilla is a cooperative state effort, sharing resources between several sister agencies including the Department of Water Resources and the Department of Parks and Recreation Division of Boating and Waterways. Other partnerships include the Delta Conservancy and Delta Area-wide Aquatic Weed Management effort, California Department of Fish and Wildlife, United States Bureau of Reclamation, and United States Geological Survey. Each lead agency has unique but complementary roles and are now strategic partners in the fight against aquatic weeds in the state. Since the Hydrilla Eradication Program's inception it has achieved some of the Department's greatest successes by keeping California effectively free of this destructive weed. One of the Program's greatest challenges has been 43,000-acre Clear Lake. Hydrilla was initially found in the lake in 1994. Herbicide treatments reduced the population to only a single plant find in 2003. Per protocol all treatments ceased in 2006 but the population quickly rebounded in the lake in 2007. The number of plants found in Clear Lake has fallen from a high of 196 in 2008 to only 4 plants in 2015. Infestations in the counties of Shasta and Nevada are approaching eradication, with no plants for up to nine years. Eradication in those counties would leave Lake and Yuba Counties with the only active hydrilla infestations in the State.

Lake Tahoe Aquatic Plant Management Program. Lars W. Anderson. USDA ARS (retired), Davis, CA, USA. lwanderson@ucdavis.edu

Despite its pristine reputation, Lake Tahoe has a number of aquatic invasive species present, including the weeds Eurasian watermilfoil and curlyleaf pondweed. The current activities in management will be discussed, as well as the plan to treat key infestations in marinas. Complicating this condition, the regulatory constraints unique to Lake Tahoe have led to the continued spread of two of the most invasive aquatic plants in North America: Eurasian watermilfoil and curlyleaf pondweed. Solutions to this situation are available but the lack of a rational balance between proven effective management actions and science-based risk evaluations continues to impede progress. This condition underscores and reveals a serious gap in the technical competence of regulatory and action agencies in spite of continuing, demonstrated threats to the ecosystem of Lake Tahoe as well as aquatic ecosystems throughout the Tahoe basin.

The California Delta – Aquatic Plant Invaders Identification and Management. John D. Madsen, USDA ARS, Department of Plant Sciences, University of California-Davis, Davis, CA, USA. jmadsen@ucdavis.edu

The California Delta is a complex freshwater estuary encompassing over 60,000 acres of surface water. A number of invasive aquatic plants have established in the Delta, creating significant nuisance problems. Invasive plants include water hyacinth (*Eichhornia crassipes*), Brazilian waterweed (*Egeria densa*), water primrose (*Ludwigia* spp.), South American spongeplant (*Limnobium laevigatum*), giant reed (*Arundo donax*), curlyleaf pondweed (*Potamogeton crispus*), Eurasian watermilfoil (*Myriophyllum spicatum*), and fanwort (*Cabomba caroliniana*). Some of the native plants with which these species may be confused, and certainly may be found alongside them, include sago pondweed (*Stuckenia pectinata*), bulrush or tule (*Schoenoplectus acutus*), American pondweed (*Potamogeton nodosus*), common waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*), floating pennywort (*Hydrocotyle ranunculoides*), and ribbonleaf pondweed (*Potamogeton foliosus*). In addition to clarifying the identification of these species, a discussion of potentially-applicable biological, chemical and mechanical, and physical control techniques will be reviewed. The current regulatory restrictions on management will also be presented to illustrate the difficulty of managing aquatic weeds in this location.

Organic/Non-Chemical Weed Management Options in Strawberries.

Oleg Daugovish, University of California Cooperative Extension, Ventura, CA, USA. Email: odaugovish@ucanr.edu

Organic production of strawberry in coastal California has been increasing. Weed control can exceed $ 2,500/acre annually in organic production and depends on costs and availability of labor for hand-weeding. For successful weed management in organic strawberry long-term planning and use of multiple tactics are necessary with consideration of their cost-effectiveness.

Field selection. Strawberry is a poor competitor with weeds. When possible, fields infested with perennial weeds (such as field bindweed or yellow nutsedge) should be avoided since no cost-effective control tools are available for those in organic systems. Evaluation of weed species and densities in the field over time helps direct the control strategies. Weeds common in strawberry production are described in the UC IPM site (http://ipm.ucanr.edu/PMG/r734700111.html) and are either present in the soil seed bank or deposited from reproductive plants in and outside the field.

Pre-irrigation before bedding stimulates germination of non-dormant weeds which can be controlled by subsequent tillage prior to planting and thus will not compete with strawberry.

Sanitation efforts such as working in the least weedy areas of the field first (and weedy–last) and cleaning equipment can minimize movement of weed prpoagules with soil and equipment to new areas. Also, control wind-dispersed weeds before flowering near your field to prevent their seed movement in to the field during the season.

Plastic mulches regardless of color (except blue and transparent) provide excellent control of most annual weeds. However, weeds will continue to germinate and compete with strawberry plants in planting holes. Reducing size of planting hole minimizes deposits and competition from weeds in them.

Yellow nutsedge shoots penetrate through plastic regardless of color and grow through these holes. *Barriers to nutsedge shoot penetration* (such as water resistant/coated paper, paper protected by plastic from moisture or weed barrier fabric) can completely prevent nutsedge shoot germination as long as their integrity persist during the season. The annual costs of barriers range from $800 to $2,000/acre.

Application of steam to soil has been very effective in controlling propagules of most annual species (75-100%) and yellow nutsedge (80-85%). Steam provides multiple benefits with disinfestation of soil from soil borne pathogens, insects or nematodes. Costs of steam application are estimated at $3,500-$4,000 but recent improvements in application technology aim at reducing these costs.

Use of weed-free substrates for strawberry production ensures that no weeds are present at planting; however wind-dispersed weed seeds deposited to wet substrate surface will germinate and compete with strawberry and should be removed. Organically acceptable substrate systems also intend to exclude pathogens and insect pests from the root zone and with proper fertigation management can ensure fruit yields similar to those in fumigated soil. However, the annual costs of these systems range from $5,000 to $8,000/acre.

Anaerobic soil disinfestation (ASD) is an increasingly common practice in organic production that relies on maintaining anaerobic conditions for 3-5 weeks with easily degradable carbon source following by aeration and planting. The changes in chemical, microbiological and physical soil environment can control or suppress some pathogens and greatly improve strawberry production. ASD efficacy for weeds is limited to warm soils (>65 F at 6 inch depth), common in southern California. Properly conducted ASD can reduce densities of most annual broadleaf weeds 50-80% while suppression of perennial weeds has been limited and carbon source dependent. Costs of ASD with rice bran as carbon source are currently $2,800-3000/acre.

Soil solarization to control weeds is only effective when soil temperatures are at least 122°F consistently for 30-45 days. In coastal California, where most strawberry is grown it is usually cooler and the solarization is not considered reliable for weed control.

Organic herbicides are typically non-selective contact materials that are oils or acids that do not translocate and have no activity on weed prpoagules in soil. They are applied to germinated/growing weeds before planting and to furrows after planting with adequate protection from drift to susceptible strawberry plants. Thus, good spray coverage improves control and dense weed stands are difficult to penetrate. An example of recently registered organic herbicide is a mix of caprylic and capric acids ('Suppress') that at 6-9% by volume controlled burning nettle, goosefoot and lambsquarter 85-100% when weeds were at 2-6 leaf stage. 'Suppress' did not control yellow nutsedge or field bindweed, though reduced their above-ground biomass temporarily. Herbicide application at the edges of furrows near plastic mulch can be especially valuable since proximity of mulch prohibits cultivation of those areas. Organic herbicides are most effective when weeds are small and loose efficacy even at increased rates when weeds mature.

Herbicidal soil amendments such as mustard seed meal, *Brassica* spp. residues or some composts can inhibit weed germination and emergence. Caution should be taken when considering application rates and timing to prevent any phytotoxic effects to strawberry crop.

Crop rotations provide opportunity for cultivation of germinated weeds (limited to furrows only in plasticiculture strawberry) and depletion of soil seedbank. Rotation to caneberries under plastic tunnels prevents weed germination in dry furrows (>60% of the area). Dense stands of vegetable crops grown from transplants can be completive with weeds, while *Brassicaceae* family crops can have inhibitory effect on weed germination due to exudation of allelochemicals.

Cover crops in strawberry furrows and surrounding areas are inexpensive ($15-25/acre seed costs) and can suppress weeds through competition and prevent new seed deposits. However, they need to be managed by mowing or organic herbicides to prevent interference with strawberry production. Even after termination cover crop residue can aid in weed control and, additionally, reduce soil erosion and losses with runoff from irrigation or rain.

Organic/non-chemical weed management in strawberry is an on-going challenge, but with consideration of field site and weed composition long-term strategies can be developed to manage weed population below the damaging threshold for strawberry production.

Weed Management in Organic Cane Berry Production. Dan O. Chellemi, Agricultural Solutions, Safety Harbor, FL

Manual weeding costs can exceed $3,000 per acre during first production year of organic raspberry and blackberry in California. Effective weed management programs will provide considerable savings in weed removal costs. In addition, effective weed management programs can improve fruit yield and quality while simultaneously reducing harvest costs. Weed management for cane berries can be broken down into three different areas; row middles, bed tops, and post rows. Each area relies upon different strategies for long-term weed management. Weed management in row middles can be accomplished through mechanical tillage, organic herbicides or mulches. For mechanical tillage, caution should be exercised to avoid damaging feeder roots extending down into the row middles. Thus, shallow tillage implements are suggested. Organic herbicides can be divided into two main groups; essential oils and acids. When using an organic herbicide for the first time, it is suggested to apply the material to a small area first to evaluate efficacy and potential phytoxicity due to drift. Mulches for row middles include living mulches, plastic mulches, or weed mats. Weed management for bed tops requires an integrated approach that incorporates raised-plastic mulched beds, organic amendments and transplant material consisting of plug plants. Both frozen and green plug plants can be transplanted into holes pre-cut into the plastic mulch, similar to transplanting practices used in vegetable production systems. Weed management in post rows can use living or plastic mulches. Grass mixtures are preferred for living mulches due to their lower water requirements, ease of management and reductions in storm water run-off during the winter rainy season.

Weeds as Hosts for Lygus Bug. Shimat V. Joseph, University of California Cooperative Extension, 1432 Abbott Street, Salinas, CA 93901

Western tarnished plant bug, commonly referred as lygus bug (*Lygus hesperus*) is an important insect pest of strawberry (*Fragaria ananassa* Duchesne) in the Central Coast of California. The adult lygus bug migrate into the managed strawberry fields and oviposit eggs and eggs hatch, and molt through five nymphal stages before molting into adults. The nymphs and adults of lygus bug feed on the embryos within the achenes which affects the normal development of tissues surrounding the embryo. The young fruits up to ~10 days after petal fall are considered vulnerable to economic injury from lygus bug feeding. The affected misshapen fruits are often referred as “catfaced” and are deemed unmarketable.

Lygus bug populations typically develop on several weed hosts surrounding the strawberry fields such as wild radish (*Raphanus raphanistrum* L.), common groundsel (*Senecio vulgaris* L.), lupines *(Lupinus* spp.), and mustards *(Brassica* spp.) and several other weed species. The previously infested second year strawberry fields are also considered as a source for lygus bug populations. Lygus bug remains on weed hosts as long as they could provide nutrients and water. When the weeds get stressed or their quality decline, the lygus bug feeding on them could disperse seeking food and water source. A laboratory study was conducted to determine walking ability of lygus bug stages and adults (female and male). Results show that adults (both females and males) walked farther at faster speed than nymphs (both young and later nymphs). Similarly, field study was conducted to determine the walking capability of 5th instar of lygus bug. The data show that the total distances moved by 5th instar of lygus bug were positively correlated with increase in surface and air temperatures. At high temperatures, 5th instar of lygus bug can move up to 10 meters and this demonstrates a strong dispersal capability of the 5th instar. The implications of these findings will be discussed.

Chemical Weed Control in Berry Crops. Steven A. Fennimore, University of California, Davis, at Salinas, CA, *Corresponding author email safennimore@ucdavis.edu

Strawberry has a very robust weed control system with several layers including: fumigants, colored mulches, herbicides, hand weeding and cultivation. Cultural practices like crop rotation and prevention of weed seed set in roadsides and ditches around the field are also important aspects of the weed control program. Strawberry is a very valuable crop and significant resources are spent to protect strawberry from weed loss, reduction in quality and weed interference with hand harvesting. While there are many aspects to weed control in strawberry, today we will focus on fumigants and herbicides.

Soil fumigants are volatile compounds that once injected into the soil disperse creating a temporary lethal condition to kill soilborne diseases, nematodes and weed propagules. While the main objective of the fumigants is to control soilborne diseases, weed control has been considered an important benefit of fumigation since the 1960s when methyl bromide fumigation came into widespread use (Wilhelm and Paulus 1980). The use of methyl bromide has been phased out in fruiting fields, but is still applied in strawberry runner plant fields where use is allowed because sanitation and plant quality are essential. Primary fumigants used now in California fruiting fields are chloropicrin (Pic), 1,3-dicloropropene (1,3-D), and metam potassium/sodium. Fumigants likely have multiple sites of action, but the primary mechanism is respiration inhibition. Weed seeds, and nutsedge tubers can be killed whether germinating or not, providing moisture conditions are adequate and fumigants are applied uniformly. The primary means of fumigant application are broadcast shank to treat the entire field, i.e., flat fumigation, where the soil is immediately covered behind the applicator and glued together in a solid sheet with each subsequent pass. Drip application of fumigants through the irrigation system is also a very common method of fumigant application. Weed seed of species like common chickweed are fairly susceptible to control with most fumigants, while hard coated weed seed like California burclover are very difficult to control with fumigants. Perennial weeds like yellow nutsedge are difficult to control with fumigants for several reasons such as the multiple growing points per tuber all of which must be killed, and the fact that nutsedge tubers can emerge from 8 to 12 inches deep which requires effective fumigant concentrations dispersed throughout a large volume of soil. Fumigant efficacy on weeds is improved though use of barrier films like TIF (totally impermeable film) which are designed to prevent fumigant emissions. TIF keeps fumigant concentrations in the soil at higher levels than standard plastic films, and weed control tends to improve with use of TIF.

Primary herbicides used in California strawberry are flumioxazin and oxyfluorfen. These products are applied across the entire field after bed formation 30 days before transplanting. Generally the herbicides are applied just before the plastic mulch is installed. It is important to have plastic mulch installed before transplanting to protect the strawberry leaves from the herbicide treated soil. Other soil applied herbicides include napropamide, and pendimethalin. Paraquat is useful in strawberry before transplanting to kill emerged weeds, and as a directed spray to kill weeds in the furrows either alone or in combination with other herbicides. Grass specific herbicides include clethodim and sethoxydim which are quite safe for use around strawberry, but are seldom used in California due to the fact that most of the weeds in strawberry are broadleaf weeds.

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Roadside and Invasive Vegetation Management in Lassen County, California.

Craig A. Hemphill, Lassen County Department of Agriculture

Weed Control in North East Calif.

1.) History- Lassen County perspective.

A. First WMA in the state.

2.) Challenges of weed management.

A. People and their priorities.

B. Limited $$$$

3.) Tools Lassen County uses in weed management.

A. Spray Equipment.

B. Herbicide selection.

C. Bio control / physical control.

4.) The impact of cooperative partnerships.

A. Public / private partnerships

Diablo Canyon Land Stewardship Program and IPM. Kelly Kephart, PG & E, Natural Resource Management

PG&E owns and manages approximately 12,500 acres associated with Diablo Canyon Nuclear Power Plant (DCPP) in San Luis Obispo County. PG&E's Land Stewardship Team is tasked with managing the property to meet license compliance related to the operation of DCPP as well as meeting Company environmental Stewardship goals. Part the Company's strategy is utilizing an IPM and adaptive management approach to range, land, vegetation, and fuels management based on objectives at various parts on the property.

Gaining Ground on Invasive Annual Grasses - New Options to Rehabilitate Our Natural Areas. Harold Quicke*[1], D. Sebastian[2], S. Nissen[2]. [1]Bayer CropScience Vegetation Management, [2] Bioagricultural Science and Pest Management Department, Colorado State University, Fort Collins, CO, USA. *harry.quicke@bayer.com.

Invasive winter annual grasses are spreading at an alarming rate across the western US, out-competing native vegetation, degrading wildlife habitat, reducing diversity and fostering more frequent, more intense wildfires. During the winter and early spring, the annual grasses exploit moisture and nutrients before native plant communities break dormancy. This results in dense stands of winter annual grasses invading disturbed areas and significant reductions or elimination of desirable perennial grass, forb and shrub species. In 2016 a new option for controlling annual invasive grasses became available with expanded labeling of Esplanade® 200 SC herbicide (indaziflam) (supplemental label not approved in California at the time of writing). Results from field and greenhouse studies document the potential to provide multiple years of control of invasive annual grasses such as cheatgrass *(Bromus tectorum)*, Japanese brome *(Bromus japonicus)*, medusahead *(Taeniatherum caput-medusae)*, ventenata *(Ventenata dubia)* and feral rye *(Secale cereale)*. After removal of the annual grass competition, remnant perennial populations quickly start to recolonize allowing for a return of diversity, improved wildlife habitat and reduced threat of damaging wildfires. Preliminary results also show the potential for reseeding perennial warm and cool season grasses into areas where remnant native populations are too low for effective recolonization. In addition to controlling annual grasses, field studies document that Esplanade can be effective as a tank mix component when targeting established biennial and perennial weeds. With Esplanade in the tank, reinvasion of weed seedlings can be inhibited.

The Next Generation of Vegetation Management and Stewardship.

Gabriel Ludwig, Vegetation Management Specialist, Helena Chemical Company, Surprize, AZ

For pesticide applicators being a good steward is now as much about using products as part of an integrated pest management program as it is about stewarding the conversation with people about product benefits, regulation and industry professionalism.

While pesticides are an essential part of the plant health and pest management tool box for keeping people, pets and communities safe and healthy, their use and benefits are often overlooked, are unknown, and can sometimes be called into question.

Increasingly, legislative proposals at the local and state levels are impacting the availability of important pest management tools while also creating doubt about state and federal pesticide regulation, and industry professionalism. In a number of states local laws are now inconsistent with state and federal law, contributing to confusion about an already complex topic.

Gabriel Ludwig will discuss local and national policy challenges to pesticide use and opportunities to steward the conversation about how and why pesticides are used. Ludwig will discuss current trends in the conversation about pesticides in communities and social media, and will provide tips about ways to talk to people about pesticides and how to add relevant and attractive content to programs and channels targeting consumers.

Turfgrass Weed Control and Best Management Practices

Prepared for the 2017 CWSS Conference
Monterey, CA

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Introduction

A good definition of "Best Management Practices" as they relate to turfgrass weed control would be as follows:

"Methods or techniques found to be the most effective and practical in achieving high levels of turfgrass weed control, while minimizing environmental impact and utilizing resources in an optimal manner"

The objectives of this presentation are as follows:

- Describe best management practices (BMP) as they relate to turfgrass weed control.
- Demonstrate the use of BMP in real life and practical turfgrass weed control situations.
- Provide updated research information on the use of new techniques, products and strategies for turfgrass weed control.

Agronomic Perspectives for Best Management Practices

- Have weeds been accurately identified?
- Annual, biennial or perennial life cycle?
- Easy or difficult to control?
- What method of control is best?
- Is hand weeding an option?
- Can herbicides be used on site?

- If so, are preemergent, postemergent or non-selective herbicides appropriate?
- Where are the weeds located: mapping?
- Is there a monthly agronomic calendar in place with weed control action plans?

Employee Training and Proper Product Use for Best Management Practices

- Are products properly stored?
- Do storage facilities meet approved DPR standards and placarding?
- Are employees properly trained?
    - Know how to read and follow a label
    - Know how to operate and calibrate a sprayer
    - Know how to determine proper application rates based on spray volume
    - Know proper application techniques with backpack and hand can sprayers
- Are employees properly certified: QAC, QAL, PCA?
- Can employees transfer academic training to the field?
- Are trained employees qualified to train other employees?

Vision for the Site and Best Management Practices

- How do you want and expect the site to look one year from now, 3 years from now, 5 years from now, and 10 years from now?
- What are the surface quality expectations relative to turfgrass quality, density, recuperative potential and aesthetic value.
- Are any weeds acceptable?
- Is there a percent or number of weeds per unit area that is acceptable?
- Are there weed types that are acceptable?
- Or, weed types that are unacceptable?

Best Management Practices for Broadleaf Postemergent Weed Control in Turf

- 10-14 days prior to herbicide applications fertilize with a 50% slow release nitrogen fertilizer at approximately 1.25 lb/M; irrigate
- Do not mow for 24-48 hours prior to application
- Do not irrigate for 36 hours after application
- Follow all label directions and instructions
- Utilize 3-way or 4-way postemergent herbicides at label rates
- Post the site as required before and after applications
- Except for English daisy, a single postemergent herbicide application will result in approximately 70%-80% control of broadleaf weeds depending on specific weed type
- Sequential applications at 4-week intervals will result in very high weed control levels (95%-100%)
- Spring applications (April-May) or late summer/fall applications (September-October) are acceptable

Summary and Practical Perspectives

- Know your weeds, their life cycles and when they are most likely to appear in turf settings.
- Select turf types that are best adapted to your microclimate and require reduced inputs.
- Be open minded, creative and always utilize BMP to achieve high quality turfgrass conditions.

* * *

Phytotoxicity of Herbicides and Abiotic Factors to Landscape and Turf - ***Causes, Impacts and Procedures for Mitigation.*** Lauren E. Howell, Director of Horticultural Services, Bemus Landscape, Inc. PO Box 74268, San Clemente, CA 92673 www.Bemus.com Lauren.Howell@bemus.com

Phytotoxicity is a toxic effect by a compound on plant growth or health. It often presents itself as plant tissue necrosis, chlorosis or plant cell distortion and stunting. Any of these is a problem for landscape management companies and their clients. Often times misdiagnosis occurs in the identification of phytotoxicity from herbicides. While actual herbicide phytotoxicity does occur in the landscape, more often the issue is actually due to an abiotic factor or an insect or disease which is causing damage. Common abiotic factors include irrigation and water issues, harmful weather conditions, damage by animals, and damage by humans and equipment.

Phytotoxicity in the commercial landscape management field happens due to poor training, improper product selection, poor application in the field, or site conditions that are not conducive to proper herbicide application. These can be mitigated with high quality, hands-on, continuous training; simplification of product selection; and an environment of concern and honesty among employees.

Damage from herbicide phytotoxicity is damaging to the landscape management industry's reputation among the public and it negatively impacts client trust and satisfaction. It creates an actual cost due to repairing damage to the property as well as a cost in wasted product and time. Knowing how to respond to possible and actual phytotoxicity damage help to minimize these costs

Improvements to the herbicide application process, which help prevent phytotoxicity, include training of field staff, spray techs, and landscape managers. Feedback from employees back to management, and suggestions and requests from landscape management companies to distributors and manufacturers are all useful in improving the systems we implement and the products we utilize.

Healthy Schools Act: 2016 Update for Turf and Landscape. Eric Denemark, CDPR, Sacramento, CA. Eric.Denemark@cdpr.ca.gov

This presentation will focus on California's Healthy Schools Act (HSA) and will discuss training, notification, recordkeeping, and reporting requirements from the perspective of school staff and contractors. This will include a practical case study to demonstrate an herbicide application at a California school site that meets all legal requirements efficiently. In accordance with the HSA, this presentation will promote low risk integrated pest management methods. This presentation will use flame weeding as an example of how the HSA relates to nonchemical pest management strategies and will also present data from the School Pesticide Use Report database specifically applicable to the CWSS and landscape pest management.

Updates in Turfgrass Plant Growth Regulator Research. Jeff Atkinson, Turf and Landscape Portfolio Leader, SePRO Corporation, jeffa@sepro.com

Plant growth regulators (PGR) are an important tool for modern turfgrass managers. Recently, Cutless MEC (flurprimidol); Legacy (flurprimidol + trinexapac-ethyl); and Musketeer (flurprimidol + paclobutrazol + trinexapac-ethyl) were registered for use by professional turfgrass managers in California.

Several studies were conducted to demonstrate how these PGRs fit into various California turfgrass systems. A study in Tucson, Arizona evaluated the effect of these PGRs alone and following ethofumesate application on *Poa annua* control, seedhead suppression, and turfgrass quality in perennial ryegrass (*Lolium perenne*) overseeded dormant bermudagrass (*Cynodon dactylon* x. *C. transvaalensis*). PGR treatments were applied 9 February and 10 March 2015. Treatments included: Cutless MEC 25 fl oz/A; Legacy 20 fl oz/A; and Musketeer 20 fl oz/A. Ethofumesate was applied in treatments including ethofumesate on 4 and 24 January at 64 fl oz/A. All treatments controlled *Poa annua* relative to the nontreated. Inclusion of ethofumesate into the treatment program improved *Poa annua* control to >85% compared to PGRs alone (60-75%). Seedhead suppression and turfgrass quality followed a similar trend.

A second study evaluated the effect of application date relative to perennial ryegrass seeding on establishment in dormant bermudagrass. Treatments included: Cutless MEC 49 fl oz/A, Legacy 22 fl oz/A, and Musketeer 30 fl oz/A. Treatments were applied to individual plots 2 weeks before seeding (WBS), day of seeding (DOS), 2 weeks after seeding (WAS) or 4 WAS. Treatments applied DOS reduced perennial ryegrass density 60% 4 WAS. Treatments applied 2 WBS or 2 WAS did not affect perennial ryegrass density relative to the nontreated. Six WAS perennial ryegrass density in all PGR treatments were similar. This result suggests turfgrass managers can continue to implement a PGR program during perennial ryegrass establishment without impacting perennial ryegrass density if label recommendations are followed.

A third study modeled the appropriate PGR application interval for creeping bentgrass putting greens utilizing growing degree days (GDD). The GDD model was developed by applying Cutless MEC at 6 and 24 fl oz/A; Legacy at 5 and 10 fl oz/A; and Musketeer at 12 and 22 fl oz/A to individual plots then collecting clipping yield every 2-3 days for a period of 1000 GDD on a base 0°C scale. These data were then used to model and predict the appropriate application interval for these PGRs based on environmental temperatures and accumulation of GDD units. The experiment determined that based on rate, Cutless MEC should be applied 210-270 GDD; Legacy 270-300 GDD; and Musketeer 290 GDD. These values are appropriate for creeping bentgrass putting greens. Additional work should be conducted to establish appropriate intervals for other turf species and turf maintained at different heights of cut.

A fourth study evaluated PGRs as a tool for turfgrass drought management. Creeping bentgrass was grown under a poly-house to exclude rainfall then irrigated with 0, 60, or 80% water lost through ET every 2-3d. Plots not receiving irrigation received no PGR, Cutless MEC 30 fl oz/A, Legacy 15 fl oz/A, or Musketeer 30 fl oz/A. Although PGR application did not entirely prevent drought stress symptoms from appearing, PGR application did improve retention of green color and improved recovery of turf when irrigation was returned in comparison to turf not treated with a PGR.

PGRs are an important and versatile tool for professional turfgrass managers. Among the many uses for PGRs, the studies presented here demonstrate their role in *Poa annua* management and water use. Further investigation and refinement of their use patterns will improve the stewardship of these technologies and expand their effective use by turfgrass mangers.

Spread and Management of Herbicide Resistant Weeds in California Rice.

Kassim Al-Khatib, Department of Plant Sciences, UC Davis, kalkhatib@ucdavis.edu

Weeds are considered a serious problem in California rice fields. Decades of using a continuously-flooded rice cropping system in California have selected specific weed species that display similar ecological requirements and growing patterns to rice. Although effective preplanting weed control and proper cultural practices including water management is used in weed management program in rice, herbicides continue to be the most important component of any weed management program in rice. 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, Late Watergrass, Redstem, Barnyardgrass, Early Watergrass, and Junglerice. In California, rice has more herbicide-resistant weeds than any other crop or region in the United States which result in more complex and expensive weed management program. Prevention, early detection and rapid response to herbicide resistant weeds is a key to manage these biotypes and prevent them from further spreading. In addition, understanding the molecular base for herbicide resistance is essential for any successful weed management program in California rice cropping system where the use of non-chemical weed control is not possible. Understanding resistance mechanisms including active site mutation, metabolic, over expression, and sequestration would help making the correct decision to manage resistant weeds. Our 2015 survey of herbicide resistant weeds in California rice fields showed that 80% of the samples tested (total is 30 samples) of smallflower umbrella sedge have resistance to sulfonylurea herbicides and propanil and the other 20% have only resistance to sulfonylurea herbicides. Resistance to thiobencarb, cyhalofop, clomazone, bispyribac and penoxsulam was evident in several populations of late water grass. We also discovered multiple resistance in a population of early watergrass where plants were resistance to penoxsulam, bispyribac, and thiobencarb. In bulrush, propanil and sulfonylurea herbicides resistance was evident in only one population. In sprangletop, there are several populations with resistance to thiobencarb, cyhalofop and clomazone. The wide spread of herbicide resistant weeds in rice field is a threat for California rice cropping system and require especial attention using IPM approach to manage these weeds.

Before Roundup Ready Crops: Was Weed Control that Great?

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Roundup Ready technology has provided California cotton, corn, and alfalfa growers with an excellent tool for managing many annual and perennial weeds. Some of the advantages to this system include the following: 1) Glyphosate can be applied postemergence so growers can wait and see the weeds present. 2) There are no plant-back restrictions. 3) Glyphosate has a wide spectrum of weed control controlling or suppressing many annuals and perennials. This technology, used in conjunction with other herbicide programs when needed, has allowed growers to reduce hand hoeing and cultivation. Hand weeding costs varied from $25 to $150 per acre depending on weed species and density.

Prior to the use of glyphosate tolerant crops the most common and difficult to control weeds in agronomic crops were nightshades, both hairy (Solanum sarrachoides) and black (S. Nigrum L.), and annual morningglory (Ipomoea spp.), that infested hundreds of thousands of acres. Perennial weeds were a problem in most fields. Nutsedge species including yellow (Cyprerus esculentus L.) and purple nutsedge (*C rotundus L.*) were the most difficult to control. Other perennial weed problems included field bindweed (*Convolvulus arvensis L.*), and to a lesser extent bermudagrass (*Cynodon dactylon L.*) and Johnsongrass (Sorghum halepense).

Mechanical Control

Weed control was easier in properly prepared fields that were not already infested with perennial weeds or difficult to control annuals. Perennials were often less expensive and easier to control in fallow fields or in certain rotation crops. Summer fallow was sometimes used to reduce purple nutsedge populations. Tubers are then destroyed with repeated summer tillage of dry soil. A spring-tooth harrow is the best tool for this. This is effective for purple nutsedge control because the tubers are susceptible to desiccation. However, dry fallow is not effective for control of yellow nutsedge because the tubers can survive up to 4 years in dry soil. Nutsedge was controlled more effectively with preplant incorporated herbicides in corn, tomatoes, or sugar beets than in cotton. Presently with glyphosate tolerant crop technology it has been so effective that it’s now difficult to even to find an infested field today.

Deep plowing to bury seeds and other reproductive organs, such as tubers, can still be an effective method of reducing weed populations. A modified moldboard plow known as a Kverneland plow, that inverts the soil 180 degrees, has been used effectively to reduce nightshade populations. This plow has been effective at reducing yellow nutsedge tubers in the top of the soil profile. By burying the tubers at least nine inches deep, nutsedge may be suppressed for 4 to 6 weeks. Purple nutsedge that emerges from deeper in the soil profile is more difficult to control.

Despite the benefits of herbicides, mechanical cultivation was then and is still one of the most important weed control methods. Cultivation is often used to remove weeds not controlled with preplant herbicides. Growers typically used rolling cultivators to control weeds and reshape beds for planting. The use of a sweep in the middle of the bed was used to cut off emerging nutsedge;

without this strategy, nutsedge can emerge before cotton and deplete the soil moisture, thereby hampering cotton emergence and seedling growth. Rolling cultivators are effective to control annual weeds, whereas, sweep-type cultivators are more effective for uprooting perennial grasses, nutsedge, and morningglories.

Preplant Incorporated Herbicides (PPI)

Dinitroanilines, trifluralin and pendimethalin, are still widely used soil-applied, residual herbicides. These herbicides are effective against most annual grasses and many broadleaf annuals; however, nightshade, mustards, and annual morningglories are not controlled by these herbicides. A tank-mix application of prometryn with trifluralin or pendimethalin just before planting, provided effective control of both hairy and black nightshades when adequate soil moisture was present. Cotton safety was compromised if rainfall moved prometryn into the root zone.

A soil fumigant, metham sodium was effective for weed control in nightshade infested fields. This treatment can suppress nutsedge for 4 to 6 weeks following application. Metham was applied in various ways; the best results in cotton were obtained when metham was applied to preformed beds with a spray blade 3 to 4 inches below the soil surface and then covered (capped) with a 2- to 3-inch layer of soil.

Postemergence Herbicides

Several postemergence herbicides are available for weeds that are not controlled by preplant or at-planting herbicide applications. Herbicides for postemergent use on cotton include sethoxydim (Poast), fluazifop - P (Fusilade), clethodim (Prism), MSMA, and pyrithiobac sodium (Staple). Nightshade control with Staple has been excellent. Best results are obtained when Staple is applied early post emergence over the top of cotyledon to 4-leaf cotton when nightshade is in the cotyledon to 2 - 4 leaf stage. Staple causes slight yellowing and crinkling of cotton leaves 4 to 7 days after application but symptoms are nonexistent 21 days and there is no significant yield reduction.

MSMA was commonly used for heavy stands of nutsedge where close cultivation is insufficient. It was applied over the top of seedling cotton less than 3 inches in height and/or post directed to the base of the cotton plants prior to the flowing stage. MSMA is about twice as effective when temperatures are 90 F. rather than 75 F.

Grassy weeds including Johnsongrass, barnyardgrass, and bermudagrass were controlled with clethodim, sethoxydim or fluazifop-P. Johnsongrass control has been excellent but, bermudagrass control has been limited unless treatment occurs soon after an irrigation or rain. Retreatment is always necessary. Tank-mix combinations of some grass herbicides with Staple herbicide may result in reduced grass control.

A postemergence-directed application cyanazine, prometryn, or oxyfluorfen can kill small annual morningglory and nightshade. Broadleaf weeds should be at the small-seedling stage with no more than two to three true leaves for effective control. Glyphosate was sometimes used for controlling field bindweed with a hooded sprayer or for spot treating perennial grasses. A sled-mounted or a shielded sprayer minimized the likelihood of crop injury. These postemergence-directed herbicides were also applied at layby (final cultivation as cotton closes the furrow) to prevent weeds at harvest.

Herbicide tolerant corn hybrids using glyphosate and other herbicides such as Liberty Link are effective technologies for corn growers, who often can reduce tillage, reduce fuel costs, and use conservation tillage systems. In Roundup Ready cropping systems, weed shifts and weed resistance occurs. Weed shifts are usually associated with reduced tillage systems and not rotating herbicides. A major concern is the development of resistance to glyphosate by lambsquarter, amaranth, horseweed, junglerice and Italian ryegrass in California. Rotating glyphosate-resistant corn with another glyphosate-resistant crop such as cotton or alfalfa will increase the chances of developing herbicide resistant weeds. To help prevent the development of herbicide-resistant weeds and prevent weed shifts from occurring, it is crucial to incorporate tillage into the weed management practices as well as alternating herbicides that have different modes of action. There is still a place for some of the older herbicides. There are many herbicide options available for growers

The following herbicides are used in corn:
Pre-Plant: Atrazine, Aatrex, Eradicane, Sutan, Roundup, Dual Magnum, Outlook, Gramoxone Inteon, Micro-Tech

At Planting: Micro-Tech, Aatrex, Atrazine, Dual Magnum, Roundup, Gramoxone Inteon, Eradicane

After Planting: Accent, Prowl, glyphosate, 2,4-D, Banvel, Clarity, Distinct, Buctril, Gramoxone Inteon, Sencor, Aatrex, Atrazine, Sandea, Shark, Yukon, Option, Outlook, Matrix (rimsulfuron).

An over-the-top application can be used, but some products or tank mixes require a directed spray on corn larger than 8 to 12 inches in height to keep the herbicide out of the whorl and to minimize the risk of corn injury. Postemergent herbicides commonly used in corn include 2,4-D, bromoxynil (Buctril), carfentrazone (Shark), dicamba (Clarity), dicamba/halsulfuron (Yukon), diflufenzopyr (Distinct), halosulfuron (Sandea), metribuzin (Sencor), nicosulfuron (Accent), and foramsulfuron (Option), Matrix (rimsulfuron). It is important, however, to pay close attention to application guidelines on the labels to avoid phytotoxicity to the crop, especially with carfentrazone (Shark).

Cultural Practices
There is no single best weed control program for all growing conditions. A vigorous, competitive crop produced through proper seedbed preparation, variety selection, seeding rates, fertilization, irrigation, cultivation, pest control, and crop rotation is the best defense against problems. A well-managed corn crop is extremely competitive with most weeds. Good cultural practices combined with timely cultivations often control weeds sufficiently to maximize yields and profit without the use of an herbicide.

Cultivation is an effective weed control method in corn. Corn should be cultivated soon after weed emergence; shallow cultivation can kill weeds without disturbing the crop if proper soil conditions exist. Shovel or sweep-type cultivators can be used later in the season if necessary. Tools used for early cultivation are the rotary hoe and the rotary cultivator. Cultivating with sweeps can significantly reduce Johnsongrass, nutsedge, and bermudagrass between rows, but weeds in the crop row may require other control practices. Corn plants taller than 8 inches have roots that extend well into the furrow. Rolling cultivators cause less root pruning than sweeps or knives, but are less effective on nutsedge, Johnsongrass, and bermudagrass. Staying at least 4 inches from the corn and throwing soil to the plant can minimize root pruning.

The herbicide tolerant systems in cotton and corn has reduced weed control costs and given growers greater flexibility. This has allowed growers to explore alternative production systems such as conservation or reduced tillage, double row configurations, and ultra-narrow row systems. The potential for herbicide resistance should receive serious and thoughtful attention. As weed management systems change with new herbicides and herbicide resistant crops are introduced, resistant management must be an integral part of the production system. This integrated weed management system supplements an existing transgenic or conventional weed control program and uses a variety of the available pre-plant, selective over-the-top and layby herbicides along with tillage.

Many of the old techniques still have a place. Keep in mind many of the weeds were not being easily controlled before herbicide tolerant technology was available. There were many herbicides, spray timings and yet still lots of weeds.

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Sharpen & Shark; Two New PPO Herbicides for Established Alfalfa.

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Marketing clean high quality alfalfa remains as much an incentive today as ever. Approximately 75% of alfalfa acreage is treated for weeds and the market rewards weed free high quality alfalfa hay by as much $100 per ton (hay market report 11/2016). Therefore, it is an incentive for producers to maintain weed free fields for economic purposes and to extend the productive life of alfalfa stands. During the winter dormant period when alfalfa is slow growing, weeds such as groundsel *senecio vulgaris*, fleabane *conyza bonariensis*, burning nettle *urtica urens*, mallow *malva spp,* flourish under these conditions and control becomes difficult. Alfalfa also has multiple cuttings with short intervals that reduces the crops ability to compete with many summer weed problems; purslane *portulaca oleracea*, pigweed *Amaranthus spp, &* knotweed, *Paspalum distichum.*

Controlling these weeds is often ineffective with current herbicides once they have emerged and can range in different growth stages and sizes. Two PPO herbicides have recently been approved for use in California, Shark *carfentrazone* approved in 2014 and Sharpen *saflufenacil* in 2016. Both show good potential to control some of the more difficult broadleaf weeds with much better efficacy. In addition, Shark can be used in season between cuttings during the summer period for problem broadleaf's that have emerged. Both herbicides are compatible tank mix partners with most post and pre-emergent herbicides and also add value in a tank mix with glyphosate in Roundup Ready varieties.

Nozzle Technologies for Effective Weed Control. Robert E. Wolf, Wolf Consulting & Research, LLC.

The selection of the proper nozzle to correctly apply crop protection and other pesticide products is becoming a more challenging process. During recent times, nozzle manufacturers have designed nozzles for the purpose of reducing spray drift. Typically, the designs have incorporated chambers, preorifices, and venturi sections to reduce pressure internally and induce air-inclusion, which will aid in the minimization of the development of small drift-prone spray droplets.

Choosing nozzles for spray drift reduction in a ground application poses several challenges for the applicator based on needs for efficacy and environmental safety. A single nozzle type produces a very different droplet spectrum depending on the design, orifice size, and pressure used with the nozzle. Applicators choose different orifice sizes and pressures depending on the speed they want to travel in the field and the spray rate they need to apply. The consideration of each of these factors changes if growers are applying a contact pesticide versus a systemic one. The challenge of reducing drift with contact pesticides is to find nozzles that reduce drift while still maintaining a small enough droplet size to obtain acceptable efficacy. This is especially true as we are entering an era where resistant and hard-to-kill weeds are becoming more prevalent.

The following table has been prepared as a summary of the nozzles discussed in this presentation.

Basic Modern Era (1980-present) Nozzle Designs for Boom Sprayers					
Nozzle Type	Company	Design feature*	Recommended use	Suggested PSI**	Comments**
Extended Range (XR)	All	Standard orifice	Not recommended	If used, 15-25 psi	Too much drift potential
Turbo TeeJet (single- TT or twin orifice- TTJ60)	TeeJet only	Preorifice and chamber	For coverage products	30-40 psi	Excellent for coverage with herbicides, fungicides, and insecticides
Low Pressure Venturi – AIXR, GA, AirMix	All	Preorifice, chamber, and air-injection inlets	For coverage and systemic products	40-50 psi	Better drift control than TT, but less than High Pressure venturi designs
High Pressure Venturi – AI, TDXL, ULD	All	Preorifice, chamber, and air inlets	Best for systemic products	50-80 psi or higher	Good option for drift reduction, but requires the higher psi for coverage & pattern
High Pressure Venturi - TTI	TeeJet	Preorifice, chamber, and air inlets	Best for systemic products	50-80 psi or higher	Best option for drift control. Also requires higher psi
Boomless Nozzle Options:					
Boom Buster	EverGreen (various distributors)	Single outlet	Roadside, pastures, 4-wheelers	30- 60 psi	Pattern width and coverage limited by pressure and wind direction
Boom Extender	Hypro and Greenleaf	Single outlet			
XP BoomJet	TeeJet	Single outlet			

*All boom nozzle designs listed are flat-fan with tapered edge patterns (heavy middles - lighter edges, not even) requiring 25-30% overlap on each edge to maintain a uniform application. Some of the types listed are available with even patterns for band applications. Also, please observe the 1:1 ratio of boom height above target to nozzle spacing on the boom (20-inch spacing = 20-inches above the target). Lower booms equals less drift potential.

**Based on authors experience and research for optimum efficacy and drift mitigation.

Interactive Effects of Grazing, Glyphosate Rate, and Application Timing on Barb Goatgrass Seedhead Production. Elise S. Gornish[1], Travis M. Bean[2*], Josh Davy[3], Guy Kyser[1]. [1]Department of Plant and Environmental Sciences, University of California, Davis, CA, USA. [2]Department of Botany and Plant Sciences, University of California, Riverside, CA, USA, [3]University of California Cooperative Extension Glenn, Colusa and Tehama Counties, CA, USA, [*]Corresponding author (bean@ucr.edu)

Eurasian winter annual, barb goatgrass (*Aegilops triuncialis*), is increasing its range in western states dominated by cool season precipitation. As an ecosystem transformer, barb goatgrass can permanently degrade rangeland and natural areas, making it a management priority. Conventional management has been largely unsuccessful, due in part to the difficulty of selectively removing undesirable annual grasses from habitats dominated by other annual grasses. Barb goatgrass has been observed to mature later than desirable species. To take advantage of this apparent separation in phenology we implemented a field experiment in five pastures at the University of California Hopland Research and Extension Center in Hopland, CA. In March through May of 2016, we applied glyphosate (Roundup WeatherMax ®) to specific barb goatgrass phenological phases (tillering, boot, heading) at high (394 g ae ha^{-1}) and low (1261 g ae ha^{-1}) rates in combination with targeted grazing by sheep (32 sheep days in each 324-m^2 plot) at the boot stage. Our goal was to minimize seed production of barb goatgrass while minimizing negative impacts to desirable forage species by evaluating the integrated efficacy of targeted grazing with precisely timed nonselective herbicide application. Plots were surveyed for seedhead densities of barb goatgrass in June 2016. Grazing reduced overall barb goatgrass density by 68%. The presence of herbicide reduced barb goatgrass density by 60% overall, but no differences in density were found between low and high herbicide rates. Spraying goatgrass at the tiller stage resulted in a 99% decline in density compared to other phenological phases. Spraying at the boot stage resulted in a 10% decline in density compared to spraying at the heading stage. No interactions were found among grazing and herbicide rate or herbicide rate and phenological stage at the time of herbicide application.

Ecologically-based Adaptive Management of Perennial Pepperweed for Endangered Species and Tidal Marsh Recovery. Brenda J. Grewell and Caryn J. Futrell, USDA-ARS Exotic & Invasive Weeds Research Unit, UCD, Davis, CA, USA. bjgrewell@ucdavis.edu

Dense infestations of perennial pepperweed (*Lepidium latifolium* L.) are recognized threats to tidal wetland habitat that undermine ecosystem restoration goals in California's San Francisco Bay-Delta Estuary. A collaborative partnership developed and implemented an adaptive plan for herbicide-based management of pepperweed and secondary invaders at Southampton Bay Wetland Natural Preserve to serve as a model for comprehensive invasive weed control to support endangered species and habitat recovery. The project includes annual, high-resolution mapping of the distribution and abundance of multiple invasive weed and endangered species populations. Experimental research has provided critical scientific input to refine spatially explicit management actions through evaluation of monitoring methods, efficacy of weed-management actions, distribution and demographic responses of rare-plant populations to management, and plant community succession. Collaborative sharing of knowledge and effective communication among interdisciplinary team members has broadened our understanding of the ecology and dynamics of the target weed and endangered plant populations, and has led to effective annual adjustments in management. In five years, pepperweed was reduced to trace levels throughout the marsh, and active control of secondary invaders is underway. During the project, the area occupied by a population of endangered soft bird's-beak (*Chloropyron molle* subsp. *molle*) increased by more than 200%. Likewise, resident special status birds [California black rail (*Laterallus jamaicensis coturniculus*) and Suisun song sparrow (*Melospiza melodia maxillaris*)] have maintained population levels.

Reforestation Following Wildfire. Stuart Gray, Sierra Pacific Industries, P.O. Box 496028, Redding, CA 96049.

Reforestation following wildfire presents a host of challenges. This presentation will begin with a discussion of conditions during the fire and actions taken immediately following a fire. Following timber salvage the burn area is broken up into management units. The planning process for each unit begins with the following considerations: What species of conifer (or mix of conifers) are the most appropriate for the site? When will the unit be planted? (Seed must be sown in a nursery 4 to 10 months prior to planting) What type of vegetation was growing on the site before it burned? Will a site prep herbicide treatment be required to hold the site until trees are available to plant? If so, will it require an air or ground application? Once the answers to these questions are determined, a working plan is put in place to repopulate the burn area with conifers in the shortest time possible.

Digital Crop Protection: Using Computer Vision and Machine Learning to Recognize and Selectively Eliminate Weeds. Jorge Heraud, CEO, Blue River Technologies, Mountain View, CA

Computer Vision and Machine Learning have been advancing at high speeds. Facebook and other sites can now correctly recognize faces of your friends, and not only know it's a person, but correctly which one of your friends is in the picture. Blue River Technology is now using similar techniques to identify weeds and crops with high accuracy, and combining them with high precision sprayer technology and closed-loop controls to precisely spray herbicides on the weeds and not in the crop. This new approach can lead to 10X reduction in chemicals used in weed control, alternatives to manual labor, and a sustainable way to control weeds including herbicide resistant ones. Jorge Heraud, Blue River's co-founder and CEO will be presenting some of the results and implications of this fascinating approach.

Automated Weeders: Where Are They Headed? Steven A. Fennimore, University of California, Davis, at Salinas, CA, safennimore@ucdavis.edu

Vegetable crops consist of dozens of crops and have varying weed management systems based on the needs of the crop. The high value of vegetable crops, limited markets and potential liability to registrants results in very few new herbicides in queue for vegetable crops. Hand weeding is very important for vegetable weed control programs due to many reasons including inadequate herbicide registrations. However, agricultural labor shortages are common and growers report difficulty in finding enough people for many farm tasks including hand weeding. Therefore, there is an overwhelming need to find cost-effective technologies to control weeds in vegetables.

There are at least three brands of automated cultivators, also called “intelligent cultivators”: Robocrop, Robovator and Steketee IC. These cultivators have machine vision systems, i.e., cameras linked to a computer, that detects the row pattern and identifies the crop based on planting pattern. Plants that are not in the row pattern are assumed to be weeds and targeted for removal. The information about the location of the crop is used to control an actuator – in this case a cultivator blade, that removes the weeds around the crop including the intra-row space, much the same as a human hoe hand.

Lettuce has for decades been seeded and thinned to desired stands by a hand weeding crew with hoes. However, decreasing labor availability and increasing costs for lettuce hand thinning has resulted in need for labor saving technologies. Recently, commercial machines capable of robotic lettuce thinning have been developed to machine-thin lettuce to the desired final crop density, helping growers reduce the cost to hand thin the crop. These systems typically utilize machine vision technology to detect plant location and accurately direct herbicidal sprays, such as carfentrazone to thin crops to desired stands. The lettuce thinners typically treat 13% of the surface area of a lettuce field spraying an intermittent band 4 inches wide with two plant lines per 40 inch wide raised bed. Within the length of the plant line, about 30% is left unsprayed to preserve the “saved” lettuce plants.

Cultivator blades and weeding knives are not new technology. What is new is the combination of steel cultivator knives with automation technology to create a new type of weed control tool. The device that contacts and kills the weed is called the “actuator”. Cultivator knives are just one such actuator – there are other possibilities such as abrasion (i.e. sand blasting), flame, superheated steam, hot oil, lasers, stampers and high pressure water jets. Intelligent cultivators work well in low density crops like lettuce, pepper and tomato where there is adequate space to separate the crop plants and differentiate them from weeds. However, high density crops such as carrot and spinach will require a different approach such as a grid spraying system. In the grid system the automated weeder would identify the weeds and differentiate them from the crop. The system would then control the weeds with a physical tool such as a flame burst or chemical spray targeted to a small spot such as a 0.5” by 0.5” square.

There are some interesting questions pertaining to development of intelligent technology. For example, herbicide molecules can be patented and protected from infringement during the duration of the patent. Machines on the other hand are quite flexible and there are often multiple ways to perform weed removal allowing for many models of weeders that do not infringe on the designs of others. Regulatory hurdles are less for physical weed control devices than for herbicide registrations, which may mean the cost of entry, is much less with machines than for herbicides. Will this flexibility discourage or encourage development of this technology? Another interesting question is who will develop this technology? Development of intelligent cultivators are very different from development of herbicides. Will chemical companies develop intelligent weeders to promote sales of their products? These questions and others will be explored in the presentation.

Artichoke Weed Control: Then, Now and In The Future. Lionell G Handel: PCA, QAL, Agricultural Consultant, Instructor, Hartnell College, Agricultural Business and Technology, Salinas, CA

Just like any crop, good weed control is one of the major task a grower must deal with during the production of artichokes. In the past there were two main approaches in controlling weeds. Timely multiple cultivations and the use of herbicides. As a minor crop (10,000 acres or less), it has been difficult to entice the manufactures towards registering additional herbicides to the cropping list. There were many problem weeds which cultivation alone, could not control of this perennial throughout the growing season.

Originally only two herbicides were registered for weed control use in artichokes, Diuron and Simazine. Later, with the help of UC Davis, Pronamide and Paraquat were added as additional tools. However, as a perennial crop, this still left a large group of weeds that were not controlled and very troublesome. Weeds were directly creating crop competition, stand reductions, and increases in crop losses due to insect and other pests including diseases.

In the '60s, the grower's created the California Artichoke Advisory Board (an artichoke grower marketing agreement) to begin to seek out possible chemical and cultural techniques to save the artichoke industry. In the early '80s it developed the Artichoke Research Association headed by Dr. Bari, to research various insect, disease, as well as rodent and other cultural concerns that were needed for integrated pest management practices. Through the IR-4 Specialty Crops Program, it conducted research seeking supplemental labeling to include many new options for pest management. This research led to several new herbicides that today, can be used as herbicidal tools to give the growers options in combating weeds.

Today, the registered herbicide list for artichokes includes: diuron (Direx); napropamide (Devrinol); pronamide (Kerb); paraquat (Gramoxone); sethoxydim (Poast); oxyfluorfen (Goal/Goaltender; pendimethalin (Prowl); flumioxazin (Chateau) and halosulfuron (Sandea). This broader range of herbicides gives the grower the advantage of switching herbicides to slow weed resistance and implement IPM.

The traditional perennial Green Globe Artichoke variety which was started by using propagated vegetative root stock from an existing field and replanted to a new field to be maintained in culture for 5 to10 years or more. Today, the traditional perennial Green Globe variety is now being rapidly replaced with new cultivars. These cultivars are new annual varieties grown for one year and then replanted to other vegetable crops. This cultural change is a benefit to the grower because he can now maximize the benefits of crop rotation and utilize other IPM practices, but it now presents new challenges such as plant-back limits, as well as leaving the field with a high seed bank profile that the new crop must face.

Major annual cultivars include, Imperial Star, Emerald, Big Heart, Green Globe, Desert globe, Green Globe Improved, and several proprietary varieties. The annual varieties are planted on a tighter planting, mainly on 80 inch beds and are staggered throughout the fall, winter, spring and summer months. New demands are put on the available herbicide to now deal with winter, summer as well as perennial weed profiles.

In the Castroville growing area, herbicides that are now being used to combat these weed profiles are: (**preplant**) Kerb, Goal/Goaltender, Gramoxone, Direx, Prowl, Chateau and Sandea; (**pre-emergent & post-emergent**) Goal/Goaltender, Gramoxone, as a directed spray over winter ditches.

Research has been actively been on-going seeking potential supplemental labeling for Shark, and Pendar to be added to the list of artichoke use herbicides.

The future of the artichoke industry is hinged on new cultural IPM practices, new chemical products to control insects, weeds and diseases that now plaque the industry, as well as new invasive species that are bound to make an unexpected arrival. New consumer demands, and more emphasis on organic farming, are just to name a few new challenges. New herbicides are a challenge due to the cost and time it takes for supplemental registrations and the lack of new chemistry to appear on the horizon. The challenge is there for growers, researchers, PCA's, and CCA's.

Overview of Organic Weed Control in Leafy Vegetable Production on the California Central Coast and Imperial Valley. Ramy Colfer, Agricultural Operations, Earthbound Farm, San Juan Bautista, CA, USA.

Weed management in organic leafy vegetables is a key challenge for growers in California. Weed management is especially costly and labor intensive for the baby crop production of leafy vegetables where mechanical weed control is generally not feasible. I review our general strategies for controlling weeds over the long term by Earthbound Farm growers. I will review some techniques and costs associated with weed management in baby crops (high density crops; spinach, leaf lettuce, etc.) and row crops (low density crops; romaine, broccoli, etc.). Also, I will review soil solarization for weed management in the Imperial Valley where it has become a standard practice for organic leafy vegetable growers.

Protecting Surface Water from Pesticide Contamination in California. K S Goh, PhD, California Department of Pesticide Regulation, Sacramento, CA, USA. [email ID]@cdpr.ca.gov

The mission of the California Department of Pesticide Regulation's Surface Water Protection Program (SWPP) is to protect surface water from pesticide contamination caused by the use of pesticides in agricultural and urban environments. The program relies on both preventive and response processes to prevent adverse impacts of pesticide residues to humans and aquatic organisms. To achieve its mission, the program integrates the following key components: a) evaluation of pesticide products submitted for registration in California, b) monitoring of surface water and sediment for high use pesticides with high aquatic toxicity potential, c) modeling of fate and transport of pesticides to predict environmental concentrations and to assess environmental risks, d) evaluation of the effectiveness of best management practices to mitigate the offsite movement of pesticides, e) outreach to pesticide users to implement best management practices, and f) implementation of regulatory measures. To implement the program mission, our scientists and analytical chemists work collaboratively with pesticide registrants, county agricultural commissioners, State and Federal agency scientists, pesticide users, and university researchers.

New Applicator Certification and Continuing Education (CE) Regulations.

Leslie Ann Crowl, Senior Environmental Scientist (Supervisor), Department of Pesticide Regulation, Pest Management & Licensing Branch, 1001 I St., Sacramento, CA 95814
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On August 5, 2015, the United States Environmental Protection Agency (U.S. EPA) proposed changes to the Code of Federal Regulations, Title 40, Part 171, “Certification Requirements for Applicators of Restricted Use Pesticides.” The Department of Pesticide Regulation (DPR) submitted public comments to the U.S. EPA regarding these proposed changes. The initial proposal included new license categories, expanded continuing education (CE) hour requirements for each category, expanded knowledge requirements, and designated time frames for accumulating CE hours.

On January 4, 2107, U.S. EPA finalized their new “Certification Requirements for Applicators of Restricted Use Pesticides” rule. This rule becomes effective March 6, 2017. The new rule has been scaled back from what was initially proposed.

The changes for private applicators include: expanded knowledge requirements, new license categories for soil and non-soil fumigation, and passing a written private applicator exam or completing an approved training program. The changes for commercial certified applicators are the addition of two new categories for non-soil fumigation and sodium cyanide predator control. Additionally, all certified applicators and noncertified applicators must be 18 years old, unless the noncertified applicator is using the restricted use pesticide under the direct supervision of a private applicator who is an immediate family member.

The revised rule has a five year implementation time. Each state has three years to develop a state plan to address the new Federal regulations and two years to implement their plan once approved by the U.S. EPA. California is still analyzing the new requirements of this rule to determine licensing options and impacts to California.

New Training Topics for Workers and Handlers and How to Tackle Them.

Lisa A. Blecker*, S. P. Risorto. Pesticide Safety Education Program, University of California Agriculture and Natural Resources Statewide IPM Program, 2801 Second Street #157, Davis, CA 95618-7774, lblecker@ucanr.edu. *Corresponding author (email address)

In January 2016, U.S. EPA published the revised Agricultural Worker Protection Standard (WPS) to increase protections for agricultural workers (those who perform hand-labor tasks in pesticide-treated areas, such as harvesting, thinning, pruning) and pesticide handlers (those who mix, load, and apply pesticides) from pesticide exposure when working in farms, forests, nurseries, and greenhouses. The changes are significant to California agriculture, and the implementation timeline is aggressive. This presentation focuses on changes to the pesticide safety training required for agricultural workers and handlers, and provides resources to help trainers comply with these new regulations. The regulatory changes that will impact pesticide safety training include: annual pesticide safety training for all 417,000 fieldworkers in California (previously, training was required once every 5 years); mandatory recordkeeping for all fieldworker pesticide safety training (previously there was no recordkeeping requirement for fieldworkers), and additional training topics for fieldworkers and handlers. The training resources presented include: the UC IPM Train-the-Trainer program (www.ipm.ucanr.edu); The UC IPM Fieldworker Training Kit; the Pesticide Educational Resources Collaborative (pesticideresources.org), and the California Department of Pesticide Regulation (http://www.cdpr.ca.gov/). The presentation includes a hands-on demonstration of how to teach one of the training topics in the field using the Fieldworker Training Kit.

Pesticide Jeopardy. Sarah P. Risorto, Pesticide Safety Educator, University of California, Agriculture and Natural Resources Statewide IPM Program, 2801 Second Street, Davis CA 95618, sprisorto@ucanr.edu

To reemphasize information delivered in prior sessions, a game of Pesticide Jeopardy was played at the end of the Laws and Regulations Session. Questions were based on information presented earlier in the Session and sourced from all speakers that day. Questions were presented in the following categories: *WPS Training* (based on Lisa Blecker's and Sarah Risorto's presentation: New Training Topics for Workers and Handlers and How to Tackle Them), *Surface Water* and *Ground Water* (based on Sam Sandoval's presentation: Best Practices to Keep Pesticides out of Water as well as Nels Ruud's and Kean Go's Presentation: Surface and Groundwater Monitoring), *Certification and Licensing* (based on Leslie Crowl's Presentation: New Applicator Certification and Continuing Education (CE) Regulations), *WPS* (based on Katy Wilcoxen's presentation: What you Need to Know about the Application Exclusion Zone (AEZ), and Leonard Herrerra's presentation: The New Worker's Protection Standard- A California Perspective, and a Final Category, *Field Postin*g (based on Blecker and Risorto's presentation: New Training Topics for Workers and Handlers and How to Tackle Them.) All questions were reviewed and revised as appropriate.

There were 285 audience members. The participants were instructed to raise their hand in order to be given an opportunity to answer each question. If the participants answered correctly they were given an option between two rewards. The first reward option was an English/Spanish bilingual UC IPM publication, "Understanding Pesticide Labels for Making Proper Applications". The second reward option was an interactive poster with included instructions for usage in training on selected Worker Protection Standard training topics. The poster was derived from part of the Fieldworker Training Kit developed by the UC IPM, Pesticide Education Program team. The participants answered 88% (23/26) of the questions correctly; 23 rewards were distributed.

Application of Partially Stabilized Organic Amendments to Inactivate *Brassica nigra* (a weed) and *Fusarium oxysporum f.sp.lactucae* (a Fungal Pathogen) Using Soil Biosolarization. J.D. Fernández-Bayo[1,2], T.E. Randall*[2], Y. Achmon[1,2], K.V. Hestmark[2], D.R. Harrold[2], J.Su[1], R.M. Dahlquist-Willard[3], T.R. Gordon[4], J.J. Stapleton[5], J.S. VanderGheynst[2], and C.W. Simmons[1]. [1]Department of Food Science and Technology, University of California, Davis, CA, USA (UC Davis), [2]Department of Biological and Agricultural Engineering, UC Davis, [3]University of California Cooperative Extension, Fresno County, CA, USA, [4]Department of Plant Pathology, UC Davis, [5]Statewide Integrated Pest Management Program, University of California, Kearney Agricultural Research and Extension Center, Parlier, CA, USA.

Composting is a widely used conversion practice for organic waste management and compost products are often applied as soil amendments due to their positive impact on soil quality. Anaerobic digestion (AD) is becoming an increasingly popular organic waste conversion process due to the potential to produce renewable biofuel as a value-added product from the waste. The by-products of AD are known as digestates, and their beneficial effects as soil amendments are currently being researched. Soil biosolarization (SBS) is an enhanced soil disinfestation process, achieved by amending soil with organic matter prior to solarization. The efficacy of SBS has been shown to be influenced by the biological stability of the organic amendments. As a result, the application of compost and digestate in SBS may be limited by the high degree of stability of these materials in their mature form. The objective of this study was to assess the impact of partially stabilized organic matter on soil biosolarization. The organic soil amendments selected for this study were derived from green and food wastes that were partially composted (PC) and partially digested. The partially digested feedstock was separated into solid digestate (SD) and liquid digestate (LD). To assess the impact of these amendments on SBS, the inactivation of two target pests was monitored. Mesocosms were loaded with a sandy clay loam soil, either non-amended or amended with the three types of feedstocks. Furthermore, the experimental plot was deliberately infested with *Fusarium oxysporum f.sp.lactucae* (FOL), a fungus causing lettuce disease. Weed seeds of *Brassica nigra* were placed at 12.5 cm depth. The mesocosms were solarized in an experimental plot or incubated at room temperature (RT, 25ºC) for eight days. Solarization of the non-amended soil increased weed seed mortality from 9.07±5.92% at RT to 18.44±7.69%. In the amended samples the mortality increased from 3.35±3.33%, 2.66±3.65% and 5.35±5.04 at room temperature to 34.05±7.94%, 33.18±15.37% and 34.15±18.21% for the soil amended with PC, SD and LD, respectively. At 5 cm, solarization reduced FOL in the non-amended soil from 275±99.25 colony forming units (CFU)/g of soil to 27.78±34.00 CFU/g. In all the amended samples FOL levels were below the detection limit (<20.8 CFU/g) at this depth. At 12.5 cm, the levels of FOL were 100±88.88 CFU/g in the solarized, non-amended soil and 41.66±20.85, 49.98±27.96 and 83.34±60.04 CFU/g for the solarized soils amended with PC, SD and LD, respectively. Although complete inactivation was not achieved after 8 days (current treatment guidelines are 4-6 weeks of heating), results show promising impacts of biosolarization with these amendments for inactivation of both studied pests. Further research is needed to understand the mechanisms involved in inactivation. Special focus is

needed on volatile fatty acid (VFA) accumulation as VFAs have previously been shown to contribute to pest inactivation.

Effects of Seeding Depth on Weed Control in Drill-Seeded Rice.

Alex Ceseski, Amar S. Godar, and Kassim Al-Khatib, University of California, Davis

Rice (*Oryza sativa* L.) is one of the most important sources of human energy worldwide and is grown in a wide range of agroecosystems, though paddy (flooded) systems are the most prevalent. In California (CA), over 200,000 ha of flooded rice are grown in a water-seeded, continuously flooded system that has successfully suppressed certain non-aquatic weed species such as barnyardgrass and bearded sprangletop. Currently, rice growers in California flood fields at the beginning of the growing season, and then pre-germinated rice seed is direct-seeded onto the flooded field by airplane. A flood depth of 10-15 cm is maintained until approximately one month before harvest, when the field is drained to allow rice harvesting. Without rotation, and with herbicides as the only method of weed control, weed populations have grown to tolerate flooding and resist many herbicides. Dry drill-seeding of rice, however, is the most common method of mechanized rice planting in the world. Previous modern studies on drill-seeding rice in California have shown that the water use and yield potential are similar to continuous flood under good nutrition and weed management. A field study was conducted near at the Rice Experiment Station in Biggs, California to investigate the effects of burial depth and the use of herbicides on weed infestation. We drill-seeded rice at 0.5, 1.5 , and 2.0 inch depths, applied 7 herbicide treatments and an untreated control. All herbicide treatments included glyphosate applied immediately prior to rice emergence. The experimental design used was a complete block design with four replications. Glyphosate applied alone controlled 50% of grass and sedge populations in all depths. In plots treated with glyphosate + pendimethalin + cyhalofop + penoxsulam, grasses were reduced by 98% at 0.5” and by 84% at 1.5” planting depths, and sedges were reduced by 100% and 98% at the same depths. In plots treated with glyphosate + pendimethalin + propanil, grasses were reduced by 88% at 0.5” and by 92% at 1.5” planting depths, and sedges were reduced by 91% and 100% at the same respective depths. The number of rice tillers was reduced by deeper planting. At 0.5” depth, rice plants had 56, 94, and 142 tillers m^{-1} in untreated control, glyphosate alone, and glyphosate + pendimethalin followed by cyhalofop, respectively. At 1.5” depth, rice plants had 24, 76, and 123 tillers m^{-1} in nontreated control, glyphosate alone, and glyphosate + pendimethalin followed by cyhalofop, respectively. However, the decline in number of tillers coincided with an increase in grain weight per panicle. The study suggests that weeds can be managed in drill-seeded rice with good cultural practices and proper weed management practices.

Temperature, Glyphosate Interactions within Roundup Ready Alfalfa.

Liberty Galvin [1], Brad Hanson [2], Steve Orloff [3]
University of California, Davis [1], University of California Cooperative Extension, Weed Specialist [2], University of California Cooperative Extension, Siskiyou County [3]

The intermountain region of northern California is known for its high-value alfalfa (*Medicago sativa* L.) forage production systems, attributed to cold night time temperatures and short growing season. Many farmers in this region prefer Roundup Ready varieties because of the ease of weed management and subsequent opportunity to maximize forage quality. In 2014 and 2015 crop injury was observed in several fields in Scott Valley, Siskiyou County following early-spring applications of glyphosate. Anecdotal evidence and results of several field experiments suggested a correlation between glyphosate application and the timing of the next frost event. To support the field research, a series of greenhouse trials were conducted at UC-Davis to determine if similar injury symptoms could be recreated under more controlled conditions. Greenhouse trials encompassed several parameters including duration and intensity of frost event, time between frost event and herbicide application, plant height, and stand age. Injury symptoms, including chlorosis, leaf curling and shoot necrosis, have prevailed more frequently with treatments combinations that include frost events, 2 hours of 0℃, occurring within 24 hours of a herbicide application on plants 12” or taller. Damage was not uniform across all replicates in each treatment, and was variable even within the injured plants themselves. Injury occasionally prolonged for several weeks, but ideal greenhouse growing conditions allowed for quick regrowth of curled leaves and chlorotic shoots. Additional research needs to be conducted to better understand the conditions necessary to reproduce injury symptoms, and to determine the underlying physiological causes of crop damage seen in the field.

Mechanical Measures Taken for Weed Control in the Mechanical Harvest of Bell Peppers. Adalia M. Cajias - CSU Chico Undergrad CWSS 2016 Scholarship Recipient

Mechanical harvest of processing Bell Peppers is growing operation that is being used in all areas of California. Through my experiences in mechanical harvest there has been some complications with encountering invasive weeds in my harvest ready pepper field. One specific field was covered in a blanket of Black Nightshade (Solanum nigrum) and had speckles of Jimson Weed (Datura stramonium) throughout the field. Through my first summer of three of my internship I recognized a huge issue of the invasive weeds slowing down harvest time, yield and quality of the crop. These invasive weeds would bind of the machine and would need to be pulled out every 15 minutes of operation. The harvesters do not have an issue up taking the weeds if they are taken in directly in the middle of the mouth of the machine but in my experiences, many of the weeds grew on the sides of the beds or in the furrows and would get caught in the sides of the mouth of the machine. The weeds getting caught would cause damage to the fruit and stop the machine and would be slowing down the harvest. Through this observation and experience of removing the weeds binding up the machine I knew change must be done. Over these next two years after this first summer I sat down with my boss and hired in help in the construction of our new harvest machines and we incorporated new additions on the machine to help with this issue. We created guard wheels on the mouth of the machine and added blades to it as well. It is a similar concept to a vine trainer for a tomato field. These additions included blades on the mouth of the harvester and rollers on the front of the machine to gather the plants and weeds into the middle. Over the three summers with the company I helped with the engineer of the additions on the equipment. My experiences of my time spent in the field were valued and incorporated. The additions showed a great success and were fully operational in the third summer I worked. The additions were incorporated on Pik Rite harvesters and Johnson tomato harvesters that were converted to harvest bell peppers.

A Population of Italian Ryegrass from Sonoma County California Exhibits Resistance to Fluazifop and Glyphosate. Caio Brunharo*[1], John Roncoroni[2], Bradley Hanson[3]. [1]PhD Student, UC Davis; [2]UCCE Weed Science Farm Advisor; [3]UCCE Weed Science Specialist, UC Davis. *Corresponding author (cabrunharo@ucdavis.edu)

Italian ryegrass (*Lolium perenne* spp. *multiflorum*) is a troublesome weedy species spread throughout California, competing for light, water and nutrients with crops. Its control has been chiefly dependent on herbicides due to their effectiveness and practicality. As result of heavy selection pressure, herbicide-resistant populations of ryegrass have been selected in California. Grapevines, particularly during the establishment years, are vulnerable to direct competition with Italian ryegrass for resources, as well as interference with cultural practices and harvest throughout their life cycle. Italian ryegrass control failure in a vineyard in Sonoma County after a Fusilade + Roundup application was reported in 2015. Greenhouse experiments were carried out to characterize the response of the suspected-resistant population of Italian ryegrass, compared to a previously characterized, susceptible population. Plants were treated with clethodim, fluazifop, glufosinate, glyphosate, paraquat, pyroxsulam, rimsulfuron and sethoxydim at various rates for the construction of dose-response curves. A field experiment was also carried out in the affected vineyard to assess the efficacy of sethoxydim (472.5 g ha^{-1}), paraquat (1050 g ha^{-1}), glufosinate (1145 g ha^{-1}), rimsulfuron (210 g ha^{-1}) and fluazifop (210 g ha^{-1}). Based on the greenhouse experiment, the Sonoma population was highly susceptible to clethodim, glufosinate, paraquat, pyroxsulam and rimsulfuron, and had moderate susceptibility to sethoxydim. On the other hand, the quantity of glyphosate and fluazifop necessary to reduce the growth of the Sonoma population by 50% was 126 and 31 times larger, respectively, compared to the susceptible (GR_{50R}/GR_{50S}). Validating the results obtained in greenhouse, poor control of the Sonoma population with fluazifop (25±3%) and moderate control with sethoxydim (66±4%) was observed in the field. Conversely, glufosinate, paraquat and rimsulfuron provided excellent (91 to 97%) control of the Sonoma population. Although having similar modes of action, fluazifop is in a different chemical group than clethodim and sethoxydim, and the mechanism that confers resistance to these herbicides might be slightly different. It should also be pointed out that, although it controlled Italian ryegrass, pyroxsulam is not labeled in grapes, which is why this herbicide was only tested in the greenhouse. These field and greenhouse experiments confirmed glyphosate and fluazifop resistance in the Sonoma vineyard site but indicated that the population was susceptible to glufosinate, paraquat and rimsulfuron.

Is Glyphosate Resistance in Junglerice (*Echinochloa colona* L.) Temperature-Dependent? Samikshya Budhathoki, Katrina Steinhauer, and Anil Shrestha, Department of Plant Science, California State University, Fresno, CA 93740

Junglerice (*Echinochloa colona* L.) is considered to be amongst the world's top ten worst weeds. It is a summer annual grass belonging to the Poaceae family. In recent years, glyphosate-resistant (GR) biotypes of junglerice have been documented in various parts of the Central Valley of California. These plants have shown four-fold resistance to glyphosate than the label rate. As such, various studies on the biology, ecology, genetics, and alternative control measures are being conducted by several researchers in California. In another weed species, *Conyza bonariensis* (hairy fleabane) it was reported that some of the GR biotypes were susceptible to glyphosate when the herbicide was applied at cooler times of the year. However, it is not known if the results would be similar in junglerice. Therefore, the objective of this study was to compare the susceptibility of GR and glyphosate-susceptible (GS) biotypes of junglerice grown under different temperature regimes to an application of label rate of glyphosate.

A study was conducted in spring and summer of 2016 in growth chambers at California State University, Fresno. Seeds of confirmed GR and GS biotypes were obtained from University of California, Davis. The seeds were germinated in plastic cells and then transplanted to 4 inch plastic pots and grown in a greenhouse set at 72° F till they reached 4- to 5- leaf stage. Each pot contained one plant. Once the plants reached the aforementioned growth stage, six potted plants each of GR and GS biotypes were placed in different growth chambers programmed for a day/night temperatures of 60° F /50° F, 77° F /68° F, and 95° F /86° F, respectively and acclimatized to the temperatures for 72 hours. After 72 hours, three potted plants of each biotype were removed from the growth chambers and sprayed outdoors with a label rate (22 fl. oz/ac) of glyphosate. The remaining three potted plants of each biotype were not sprayed and used as controls. The plants were immediately placed back in the growth chambers after spraying and grown in the respective temperatures mentioned above for 7 additional days. On the eighth day, all the plants were moved to the greenhouse set at 72° F and allowed to grow for 21 additional days. The plants were then evaluated for mortality on a 0 to 100 scale (where 0 = complete death of the plant with no green tissue and 100 = completely alive with no herbicide damage). The plants were then clipped at the surface of the soil and their dry weights were recorded after drying them in a forced air oven set at 140° F for 72 hours. The experiment was repeated four times. The experimental design was a randomized complete block where the blocks were the experimental runs over time. Data were analyzed at the 0.05 level of significance.

Results showed that none of the glyphosate-treated GS junglerice plants survived at any of the temperature regimes tested while all of the untreated control GS plants survived in all the growth chambers. Among the GR plants, all the sprayed and untreated control plants survived in the 77° F /68° F and 95° F /86° F temperature treatments. However, all the GR plants sprayed with glyphosate died in the 60° F /50° F treatment, whereas the untreated control plants survived in these chambers. The biomass of both GR and GS junglerice untreated control plants were reduced under cooler temperatures. Therefore these results showed that glyphosate resistance in junglerice was dependent on the temperatures they were exposed to before and after they were sprayed with glyphosate. It needs to be determined what the practical implications of this finding may be for field conditions and what role temperature has in regulating the resistance mechanism of junglerice to glyphosate.

Dormancy Requirements of Hairy Fleabane (*Conyza bonariensis*) Seeds. Vivian Maier and Anil Shrestha Department of Plant Science, California State University, Fresno, CA 93740

Hairy fleabane (*Conyza bonariensis* L. Cronq.) is considered a summer annual weed in California. However, it is often seen to be growing year round in the Central Valley. This is primarily because there are two major periods of germination of this species in the Central Valley. It either germinates and emerges in fall, over-winters as a rosette, and completes its life cycle in early summer or it germinates and emerges in late winter and completes its life cycle in late summer or early fall (Shrestha et al. 2008). This species is known to produce as many as 226,000 seeds per plant (Kempen and Graf 1981). Although the optimal temperature of seed germination for this species ranges between 65º to 75º F, it has been reported to germinate at temperatures as low as 39.5° F (Wu et al. 2007). The seeds are also reported to be able to germinate under moderate water stress of up to -0.4 MPa (Karlsson and Milberg 2007). This species, similar to horseweed, is primarily a surface germinating type, i.e. its germination is reduced when buried more than 1 mm deep. Although much information is available on germination ecology of horseweed (*C. canadensis* L. Cronq.), very limited information is available for hairy fleabane. For example, it has been suspected that its seeds may not have a long dormancy period for germination. Therefore, the objectives of this study were to determine the dormancy and moisture requirement of hairy fleabane seeds for germination.

A study was conducted in Fresno, CA in 2016 in a lab under room temperature of 72º F and ambient light conditions. Seeds of hairy fleabane plants were collected from vineyards in Fresno. Seeds of five random plants were collected and bagged separately. Twenty five seeds from each hairy fleabane plant were placed on Whatman No. 1 filter papers placed in separate 100 by 15 mm Petri dishes. Ten ml deionized water was added to each petri dish with a pipette. The seeds were tested for germination, a) the day they were harvested, b) one week after they were harvested, c) two weeks after they were harvested, and d) three weeks after they were harvested. The petri dishes were periodically examined for germination till the process ceased. A seed was considered to have germinated if they had a 1 mm long radicle and plumule. The experiment was arranged as completely randomized design where the different days after harvest were the treatments and each plant was a replicate.

Another study was conducted to determine the level of tolerance to moisture stress during germination. The study was also conducted in the same lab under similar environmental conditions. Solutions of various water potentials (0, -0.149, -0.51, -1.09, -1.88, -2.89, -4.12, and -5.56 MPa) were prepared using polyethylene glycol (PEG 6000; Fisher Scientific, Houston, TX). Twenty seeds from each hairy fleabane plant were placed on Whatman No. 1 filter paper placed in separate 100 by 15 mm Petri dishes. Ten ml of the different ψ solutions were added to each Petri dish with a pipette. The Petri dishes were then sealed with parafilm (Parafilm M™ Wrapping Film, Fisher Scientific, Houston, TX). Germination was monitored as described above. Total germination at 0 MPa was considered 100% and the percent germination in the other treatments were calculated relative to germination at 0 MPa. The experimental set up was a completely randomized design where each plant was a replicate. The experiment was repeated. Data for both experiments were analyzed using analysis of variance procedures and the means were separated by Fisher's least significant difference process at a 0.05 level of significance. A non-linear regression was also fit to the data on moisture stress.

More than 54% of the seeds that were put in the petri dishes the day they were harvested germinated; although, the germination percentage was significantly lower than the other treatments. Total germination in the other treatments ranged between 68% to 72% and there were no significant differences between the treatments in total germination percentage of the seeds. In the moisture-stress study, up to 71% of the seeds germinated at – 0.149 MPa, a few (approximately 10%) seeds germinated at -0.51 MPa but none of the seeds germinated in the other treatments. The non-linear regression estimated that the water potential to reduce germination by 50% was approximately -0.28 MPa.

This study showed that hairy fleabane seeds could germinate the day they fall off from the mother plants. However, they need adequate moisture to germinate and it is not very drought-tolerant in terms of seed germination compared to several other weed species.

References:

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Weed Seed Inactivation Using Biosolarization with Mature Greenwaste Compost and Tomato Pomace Amendments. Y. Achmon*1,2, J. Fernández-Bayo1,2, K. Hernandez3,4, D. McCurry3, D. Harrold2, J. Su1, R. Dahlquist-Willard3, J. Stapleton5, J. VanderGheynst2, C. Simmons1. 1Food Science and Technology and Biological and Agricultural Engineering Departments, University of California, Davis, CA, USA, 3University of California Cooperative Extension, Fresno County, CA, USA, 4School of Natural Sciences, Fresno Pacific University, Fresno, CA, USA, 5Statewide Integrated Pest Management Program, University of California, Kearney Agricultural Research and Extension Center, Parlier, CA, USA.
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Biosolarization is a fumigation alternative that combines passive solar heating with amendment-driven soil microbial activity to temporarily create antagonistic soil conditions, sruch as elevated temperature and acidity, that can inactivate weed seeds and other pest propagules. A potential advantage of biosolarization over soil solarization without amendments is increased biocidal activity, which can shorten treatment time and allow usage in marginal climatic areas or during less favorable weather conditions. The aim of this study was to employ a mesocosm-based field trial to assess and compare soil heating, pH, volatile fatty acid amendment, or soil amendment without solarization. Biosolarization for 8 days using 2% mature greenwaste compost and 2 or 5% tomato pomace (processing residues) in the soil resulted in accumulation of volatile fatty acids in the soil, particularly acetic acid, and >95% inactivation of black mustard (Brassica nigra) and black nightshade (Solanum nigrum) seeds. Inactivation kinetics data showed that near complete weed seed inactivation in soil was achieved within the first 5 days of biosolarization. This was significantly greater than the inactivation achieved in control soils that were solarized without amendment, or were amended but not solarized. The composition and concentration of the organic amendments in soil significantly affected volatile fatty acid accumulation at various soil depths during biosolarization. Combining soil solarization with the selected organic matter amendments resulted in accelerated weed seed inactivation, compared with either treatment alone. The exploitation of agri-food wastes can be useful in sustainable soil pest management treatments, and in waste management cost reduction efforts. REFERENCE: Achmon, Y. et al.,2016. Pest Management Science, 10 AUG 2016, DOI: 10.1002/ps.4354. Online: http://onlinelibrary.wiley.com/doi/10.1002/ps.4354/full

CWSS Cash Flow Report and Investments
July 1, 2016 – March 22, 2017

Ordinary Income/Expense	
Income	
4000 · Registration Income	128,748.00
4001 · Membership Income	945.00
4020 · Exhibit Income	22,400.00
4030 · Sponsor Income	9,401.00
4040 · CWSS Textbook Income	726.36
4065 · Orchid Fundraiser	330.00
4290 · Refunds	-3,396.00
4296 · MISCELLANEOUS INCOME	10.00
Total Income	159,164.36
Gross Profit	159,164.36
Expense	
4300 · Conference Accreditation	195.00
4320 · Conference Catering Expense	46,130.09
4330 · Conference Equipment Expense	1,671.01
4360 · Student Awards/Poster Expense	2,000.00
4361 · Awards-Board/Special Recog.	204.64
4370 · Scholarship Expense	8,000.00
4380 · Conference Supplies	2,434.07
6090 · Advertising	975.00
6105 · Merchant Services Fees	5,341.62
6130 · Board Meeting Expenses	451.80
6240 · Insurance - General	3,303.00
6270 · Legal & Accounting	2,642.51
6280 · Mail Box Rental Expense	86.00
6300 · Office Expense	514.58
6307 · Outside Services - PAPA	33,014.48
6340 · Postage/Shipping Expense	108.80
6345 · Printing Expense - Newsletter	495.68
6355 · Website Expense	951.90
6440 · Supplies Expense	78.56
6500 · Taxes - Other	19.30
6530 · Travel - Transport/Lodging	1,794.64
6540 · Travel - Meals/Entertainment	548.39
6545 · Student Travel - Transport/Lodg	1,770.44
6550 · Student Travel - Meals	242.30
6555 · Speaker Lodging/Travel Expense	1,860.56
6570 · Miscellaneous	202.10
Total Expense	115,036.47
Net Ordinary Income	44,127.89
Net Income	**44,127.89**

Edward Jones Investment Account Balance as of 2/24/17 - $299,901.73

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*President's Award for Lifetime Achievement in Weed Science

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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