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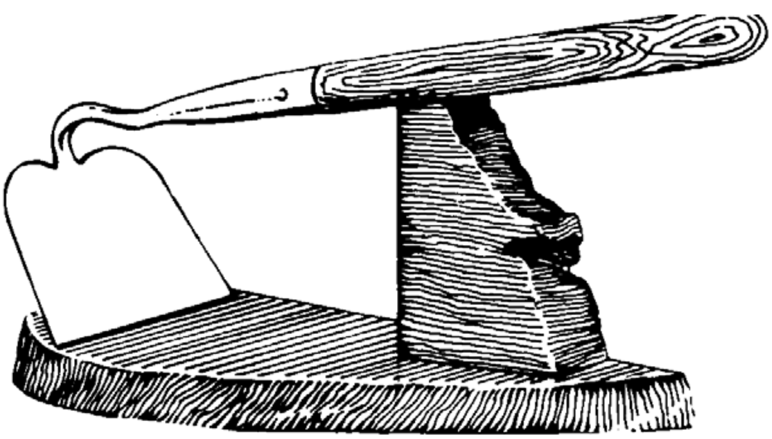
72ND ANNUAL CONFERENCE OF THE

CALIFORNIA WEED SCIENCE SOCIETY

"Back to the Future: Implementing New Technologies to Address Current and Emerging Challenges in Weed Management"

PORTOLA HOTEL & SPA
Monterey, California

January 22, 23, & 24, 2020



CWSS 1948-2020

2020 Proceedings of the California Weed Science Society

Volume 72

Papers Presented at the 2020 Annual Conference
January 22, 23, & 24, 2020

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Preface

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

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CWSS 2020 AWARD RECIPIENTS

Presented by Brad Hanson, CWSS President

This year's recipients have made tremendous contributions to the society mission in the following areas: the information exchange through research, publications, facilitating cooperation amongst individuals, encouraging careers in weed science, and promoting professional growth for members. I am proud and honored to present these awards to the worthy recipients.

<u>Awards of Excellence</u>

Ben Duesterhaus

Ben is a graduate of Texas Tech University with a B.S. in Agronomy and an M.S. in Agricultural Seed Science. Prior to moving to CA in 2007, ben worked in the seed industry. He moved to CA where he worked as a Technical Service Rep for BASF before starting his current role as a Technical Service Agronomist with Mid Valley Agricultural Services. Been has been an active participant in the CWSS since he moved to CA, serving as a session chair for many years and recently completing a term on the CWSS Board of Directors as a Director and the Chair of the Steering Committee.

Dr. Lynn Sosnoskie

Lynn received her M.S. in Plant Pathology from the University of Delaware and her Ph.D. in Weed Science from The Ohio State University. Upon completing her education, Lynn served in multiple research and extension roles at the University of Wisconsin -Madison, University of GA-Tifton, Washington State University-Wenatchee and UC Davis. She then worked as the Agronomy and Weed Science Advisor with UCANR in Merced. Lynn recently accepted a new position as an Assistant Professor in Weed Ecology and Management for Specialty Crops at Cornell University. Lynn has been a presenter and session chair for multiple CWSS Conferences, and has been a great contributor to the society as a current member of the Board of Directors. We would like to recognize Lynn's contributions to the society and Weed Science research in CA and the West and wish her the best in her new position at Cornell.

Honorary Members

Kurt Hembree

Kurt began his career at Fresno State University, receiving a B.S. degree in Plant Science and a M.S. degree in Plant Protection. Upon completing his M.S., Kurt worked as a Research Associate at UCCE, Fresno County. In 1994, Kurt started in his current role as a Fresno County Weed Science Farm Advisor. Kurt has made numerous contributions to the Weed Science community in CA row crops, orchards, vineyard and non-crop areas; including his involvement in the discovery and management of glyphosate resistant horseweed and hairy fleabane in CA orchards. More recently, his research has also focused on improving weed efficacy using drift reducing nozzles. The contributions Kurt has made in the field during his career have been shared with the CWSS through numerous presentations and active participation in the CWSS Annual Conference. We would like to honor Kurt for his many years of service to the society and his research contributions to Weed Science in California.

Richard Smith

Richard Smith completed his M.S. at UC Davis and has served over 25 years with UC Cooperative Extension. He is the Farm Advisor for Vegetable Crop Production & Weed Science in Monterey County. His research program has addressed vegetable production and weed control issues. Richard has been an active participant in the CWSS providing research updates on his weed control research to the membership during his career. He is a previous recipient of the CWSS Award of Excellence, and I would like to take this opportunity to recognize Richard's accomplishments and contributions to the CWSS throughout his career.

2020 CWSS STUDENT RESEARCH PAPERS & POSTER CONTEST

Students pictured left to right: Matthew Fatino, Guelta LaGuerre, Drew Wolter, James Schaeffer
Not pictured: Alex Ceseski

Student Research Paper Awards

Presented by Thomas Getts, CWSS Director, Student Liaison

1st Place – Drew Wolter, University of California, Davis
Can Trunk Paint Mitigate Herbicide Damage in Young Almond Trees?

2nd Place –James Schaeffer, California State University, Fresno
Alkaliweed Invasions and Adaptations in Pistachio Orchards

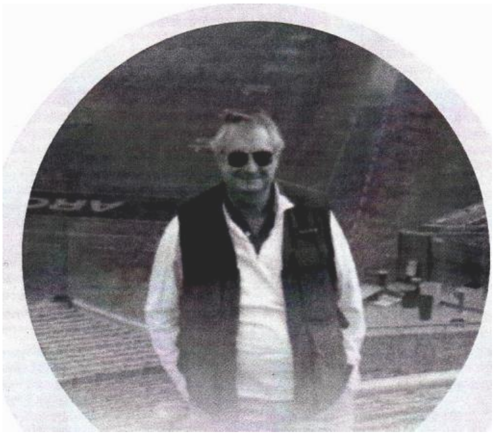
Student Poster Awards

Presented by Thomas Getts, CWSS Director, Student Liaison

1st Place Graduate Tie – Matthew Fatino, University of California, Davis
Evaluation of Growing Degree Day Based Chemigation Treatments for Management of Branched Broomrape in California Processing Tomato Systems.

2nd Place Graduate Tie – Alex Ceseski, University of California, Davis
Effects of Deep Seeding on Weed Management and Crop Response in California Rice Systems.

1st Place Undergraduate – Guelta Laguerre, University of California, Davis
Understanding the Impact of Early Season Algae Infestation on Rice Seedling Emergence and Establishment.



In Memoriam

Stephen T. Cockerham

February 19, 1939 - December 30, 2018

Known as the humble farmer, Stephen T. Cockerham, 79, forty-year resident of Riverside, CA, passed away on December 30, 2018, at Riverside Community Hospital following complications from treatment for melanoma. Steve was born on February 19, 1939 in Elwood, Indiana to Theodore and Inez Cockerham. Steve is survived by his wife, Barbara , and their son, Fernando Gabela and wife Alicia, and two granddaughters, Jessica and Jackie, who reside in Diamond Bar. He has one younger sister, Joyce Valley (Duane), who lives in Pelican Rapids, Minnesota. His niece Jodie lives nearby in Norco. Nephews Scott and Randy reside in Minnesota. He has innumerable grand nieces and nephews in Minnesota as well. Also an integral part of the family system includes Laurie McLaughlin, Barbara's sister, and her daughters, Erin (Josh), Meaghan (Tony), and Kate (Matthew) and their children. Laurie lives two houses away from the Cockerham home. He was preceded in death by his son, Garrett Charles in 1985, and by his parents. Steve graduated in 1961 from Purdue University as an agronomist in turfgrass science. He later earned a MS in Turfgrass Science from New Mexico State University and an MBA from Southern Illinois University at Edwardsville. Steve served as a Peace Corps volunteer in El Salvador from 1962-64 where he met his wife of 54 years, Barbara, who was serving as a missionary secretary. They enjoyed spending time with other volunteers and driving around in a little blue jeep. He had an amazing 56-year career in turfgrass-related endeavors including 30 year consulting with the LA Coliseum beginning with the 1984 Olympics, assisting with the design of the Bank One Ballpark (Chase Field) in Arizona in the mid 1980s, and ensuring the quality of the multiple playing fields used for the 1994 World Cup. For five years (1979-1983) he was a farmer in Perris, CA with his own sod farm. From 1983 through 2009 he served at the University of California, Riverside as Superintendent of Agricultural Operations. During his tenure there he conducted extensive research and extension with his colleagues, especially Dr. Victor Gibeault, his best friend. His technical professional writing was highly valued in journals, books and extension publications. Steve loved to travel, especially throughout the Southwest including Four Corners. A recent valued moment was enjoying the Skywalk at the Grand Canyon. His hobbies included golf, photography, Purdue sports, reading and music from country to classical. He was noted for his dry wit and sense of humor. Steve's final resting place is at Olivewood Cemetery in Riverside.

Plant Optics: Potential and Limitations of Remote Sensing for Weed Management. Magney, T.S., Department of Plant Sciences, University of California, Davis, Davis, CA

Recent advances in remote sensing science have enabled new ways to 'see' plant structure, composition, and function. Based on a fundamental understanding of the way plants absorb, reflect, and re-emit light, we can now see 'beyond greenness', enabling a finer understanding of plant dynamics in both time and space. Many of these advances come from looking deeper into the electromagnetic spectrum, where specific wavelengths hold clues about plant photosynthesis, stress, water content, proteins, and pigments. New hyperspectral and laser-based remote sensing techniques hold promise for mapping weed dynamics in time and space. In this presentation, an overview of these technologies and their application in precision weed management will be introduced. Spatial, temporal, and spectral considerations for determining the right 'tool' for the application will be discussed. An emphasis will be placed on techniques that are actively in development but have not yet been applied for practical applications.

Building a Weed Management Program with High-Resolution Image Data.

Raul E. Pena, Regional Vice President - Western Region for TerrAvion,
at raul@terravion.com or at 707-934-8272.

TerrAvion - Background

- We were founded in 2013
- Our founder & CEO of TerrAvion led the first US Army drone platoon in Afghanistan and our company employs 15% veterans
- We deliver the largest volume of aerial imagery for the agriculture industry since 2016
- We deliver the highest reliability in industry and lead the industry in partner integrations

TerrAvion - Precision Aerial Imagery for Weed Management

- Identify and map weed infestations: TerrAvion high-resolution NDVI imagery is capable of identifying pre-plant and post-emergence weeds and differentiating from healthy crop .
- Make imagery guided variable rate herbicide applications: Blanket rate herbicide applications are inefficient, wasteful, and can be ineffective. Imagery guided variable rate applications provide adequate rates on herbicide to severely infested areas prevent reemergence and limit waste.
- Monitor weed infestations throughout the year: Monitor the effectiveness of herbicide treatments. Identify recurring weeds during the season and target for post-emergence applications.

TerrAvion - Weed Management

- Pre-plant & Day of Planting Herbicide Applications
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- Pigweed Infestation
- Weed Pressure in Permanent Crops

TerrAvion uses fixed-wing crewed aircraft equipped with the latest imagery technology

- Synthetic Color < 10 cm/pixel
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We Believe Our Fixed Wing Aerial Imagery is the Key for Digital Agronomy

- is significantly more scalable and less expensive than drones
- provides higher quality imagery than satellite
- enhances ground truthing by targeting zones with precise coordinates
- provides the imagery within 12 hours of the flight

Drone Based Precision Weed Mapping in Agriculture. Kris Poulson. Sentera, Richfield, MN, USA. (Kris.poulson@sentera.com)

Sentera is the global technology leader for in-season data, analytics, and insights for growers, deployed at scale. Sentera's products make it easy for users to integrate in-field data insights with the digital ag platforms in use by more than 80 percent of the growers in North America. Sentera's equipment has flown tens of millions of acres all over the world, and processes hundreds of terabytes of new data for its customers every year.

Some of the data that Sentera processes is for high precision weed mapping. Through computer vision and machine learning (CVML) Sentera can accurately identify weeds and create a nozzle by nozzle spray prescription for spray equipment execution. Sentera does this by using their proprietary CVML techniques on drone imagery.

Turnaround times are quick, and the customers usually see about a 70% reduction in chemistry that needs to be applied on average to their fields. This is all done with no change in efficacy and yield verses traditional spray methods. This technology has been thoroughly tested at the university, researcher and grower levels. The product was officially launched in 2018 and is commercially available to the public.

Benefits of Computer Vision and Robotics for Effective Weed Control in Vegetable Production. Sebastien Boyer. FarmWise Labs, San Francisco, CA, USA. (sebastien.boyer@farmwise.io)

In-season weed control management in both organic and conventional vegetable crops mostly relies on labor intensive hand weeding. However, in California, vegetable growers are reporting drastic labor shortages of field workers. Artificial intelligence (AI) and in particular deep learning, one of its nascent subsets, has been used in various industries for the detection of faces and objects. Applied to farming, this relatively new field is now enabling computers to self-learn how to recognize plant species from one another and distinguish characteristics of the identified plants (stem location, number of leaves, size, volumetric data). Mixed with robotics - another emerging technology that has been successfully leveraged in sectors such as the automotive industry and healthcare - computer vision is now opening the door to the development of innovative weed control tools. FarmWise has built a self-driving general robotic platform that mechanically weeds in-between the rows and in-between crops using crop-recognition capabilities and blades. Today, the machines work on leafy greens. Building generalized learning models that can detect a broad range of crops and weeds, and a robotic system that can effectively work in difficult soil types remain technical challenges facing these technologies today. Looking ahead, the same technologies carry the great potential to optimize pest control applications and enhance Pest Control Advisors' work by offering early detection of pest and diseases.

Cyperus difformis Cross-Resistance to ALS Inhibitors in California Rice Fields

Alex Ceseski, K. Al-Khatib, Department of Plant Sciences, University of California Davis, Davis CA, USA

Populations of *Cyperus difformis* L. (smallflower umbrella sedge) resistant to the ALS inhibitor bensulfuron-methyl were discovered in California rice fields in 1994, four years after its release. Since then, *C. difformis* populations resistant to each ALS inhibitor registered for California rice have been identified. To adequately inform growers of their *C. difformis* management options, and inform the rice industry of the magnitude of the ALS resistance issue, a comprehensive characterization of the scale, distribution, and mechanisms of ALS inhibitor cross-resistance is required. Sixty-two populations of *C. difformis* suspected to be ALS inhibitor resistant were collected from throughout the region, and screened for cross-resistance. Herbicides administered were bensulfuron-methyl, halosulfuron-methyl, bispyribac-sodium, and penoxsulam, applied at discriminating rates of 70.1 & 210.3, 70.1 & 210.3, 37.4 & 112.2, and 42 & 126g ha^{-1}, respectively. Six populations of *C. difformis* confirmed ALS cross-resistant were self-pollinated, and S-1 seed were tested for resistance levels via dose-response with the abovementioned herbicides, with rates ranging from 13.3-852, 13.3-852, 7.1-455, and 8-510g ai ha^{-1}, respectively. All herbicide treatments were administered with required adjuvants in a compressed-air singletrack spray booth fitted with one 8002EVS tip, delivering 187L ha^{-1}. Screening revealed six major patterns of ALS inhibitor cross-resistance, with no apparent geographic distribution pattern. Each population tested was resistant to bensulfuron-methyl, with average survival of 75% at the lower rate. Twenty-one populations were susceptible to halosulfuron-methyl, even though it and bensulfuron-methyl are sulfonylureas. Only three populations showed resistance to penoxsulam; two were resistant to all four herbicides. Dose-response confirmed that the majority of resistance in the tested populations was dose-dependent, suggesting nontarget-site resistance mechanisms. Two populations showed high survival at the highest herbicide rates, with RI's >200, and therefore may possess insensitive ALS enzymes. Studies to elucidate target- and nontarget mechanisms of resistance are underway.

Alkaliweed Invasions and Adaptations in Pistachio Orchards

James Schaeffer[1,2], K. Hembree[1], A. Shrestha[2]. [1]University of California Cooperative Extension, Fresno, CA, [2]California State University, Fresno, CA. Jschaeffer@mail.fresnostate.edu

Alkaliweed (*Cressa truxillensis*) is a California native perennial plant species found throughout the state primarily in saline and alkaline soils. This species belongs to the *Convolvulaceae* family, which includes several problematic weeds common to Central Valley counties. These include field bindweed (*Convolvulus arvensis*) and dodder (*Cuscuta* spp.). Until recently, alkaliweed has been primarily associated with natural areas, field margins, and ditch banks. Populations are now being widely observed in tree nut orchards, agronomic crops, fallow fields, ditch banks, and roadsides. More noticeably, numerous young pistachio (*Pistacia vera L.*) orchards in the southern San Joaquin Valley have been completely invaded by this plant, causing a monoculture weed presence in infested fields. Standard orchard floor management practices, such as cultivation and herbicide application, have had limited or no success on its control. The need for management strategies is paramount as grower concern builds. Anecdotal evidence and observations lead one to believe that alkaliweed persists due to both its above- and below-ground plant parts. While flowers and seed are produced, little is known on its contribution to alkaliweed invasion and spread. There is very limited information available in literature on alkaliweed. Therefore, there is a need for research on the plants fitness and ability to survive and spread. A laboratory study was conducted to determine soil attributes (pH, salinity, water potential) necessary for alkaliweed seed germination. Secondly, a field study evaluated the influence of shading (30% shade, 50% shade, and full sunlight) on above-ground plant response. Data collection has ended and is in the process on being analyzed.

Water Potential and Temperature Effects on Germination of Weedy Rice Under Controlled Conditions. Liberty Galvin*, Mohsen Mesgaran, Kassim Al-Khatib University of California, Davis, Department of Plant Sciences. *Corresponding author (Lbgalvin@ucdavis.edu)

Weedy rice (*Oryza sativa f. spontanea Rosh.*) has recently become a problematic weed in California due to its conspecific features, competitive growth habit, and early maturation. Because of this, early season growth and development of weedy rice should be well understood before the creation and implementation of control strategies. The objective of this experiment was to determine what range of water potentials and temperatures would promote or inhibit germination of California weedy rice accessions 1, 2, 3, 5 as well as M206, a common medium-grain, median maturity variety grown in California. Seeds were primed with heat treatment and germinated at a range of temperatures from 10-35°C in 5°C increments, and a range of water potentials, from 0 to -0.8 MPa in -0.2 MPa increments under controlled conditions. Contrary to the literature, the base temperature for M206 was not 10°C, indicated by a significant amount of germination at 0 MPa; however, weedy rice seeds did not germinate significantly at temperatures below 15°C regardless of water potential. At 30°C all weedy rice accessions as well as M206 reached 50% germination within 5 days after seeding regardless of water potential. This was the fastest rate of germination compared to other temperature and water potential combinations and provides evidence that 30°C may be optimal for germination. Weedy rice accessions responded differently when exposed to similar temperature and water potential combinations, inferring that germination at the field level may vary depending on accession. Results from this experiment can be used to estimate when weedy rice seeds will germinate in the field, allowing growers to adjust the timing of their early-season control strategies.

Can Trunk Paint Mitigate Herbicide Damage in Young Almond Trees?

Drew Wolter[1], Dani Lightle[2], and Brad Hanson[3]
[1]UC Davis Weed Science Graduate Student, UCCE Junior Specialist Horticulture Intern
[2]UCCE Orchards Advisor, Glenn, Butte & Tehama Counties
[3]Weed Science Specialist, UC Davis

Weed control in young orchards is critical for good establishment and early growth, which can impact long-term success of the crop. Postemergence herbicides that are safe on older trees, with hardened and mature bark, may not be safe on young almond trees, with thinner and tender green bark. A standard pomological practice in California almond, walnut, and prune production is to apply white latex paint to the lower 2 to 3 feet of the trunk, in an effort to protect them from postemergence herbicides; however, research on the efficacy of this practice is lacking. A field experiment was conducted in Arbuckle, CA to evaluate the impacts of latex paint on sensitivity to herbicide injury in young almond trees.

The experimental design was a split plot with a 4 by 7 factorial combination trunk protection and herbicide treatments and four replicates of each treatment combination. For the trunk protection main effect, second-leaf almond trees given one of four categories of trunk protection: old paint (9-week old), new paint (2-day old), no paint (hardened-off for 9 weeks), and cartoned. The cartons for the "no paint" and "old paint" treatments were removed for the first time, nine weeks before the herbicide applications, exposing green bark. Valspar interior latex paint, diluted 50:50 with water, was then applied using a painter's mitt to the group of trees in the old paint treatment. This also allowed for the no paint treatment to harden off for nine weeks prior to the herbicide application. Two days prior to the herbicide applications, the cartons for the new paint treatments were removed for the first time and the trunks were painted. The cartoned treatments in this experiment never had their cartons removed. On June 20th, 2019 herbicide treatments including two rates each of glyphosate (Roundup PowerMAX), glufosinate (Rely 280), or a tank mix of both were applied. Herbicide applications were made using a CO_2 backpack sprayer at 35 psi, and a spray volume of 20 gallons/acre. A single nozzle was held 18 inches from the trunk, moving vertically (from top to bottom) for one second on both the eastern and western sides of the trees.

Results from the 2019 trial indicated that paint as a trunk protection method may not provide significant protection from glyphosate or glufosinate. Tree stress caused by trunk-applied herbicides was lowest in the painted and non-painted treatments where trunks were allowed to harden off for nine weeks, which suggests that hardening of the bark is key to mitigating herbicide damage in young trees. For example, trees treated with the top-of-label-rate, tank-mix of glyphosate and glufosinate had 4-22% greater trunk damage than trees that were not painted. The most efficacious trunk protection option for young almonds trees is to install a carton; however, when cartons are eventually removed green bark may be present and susceptible to herbicide injury. Therefore, a key grower recommendation of this research is to time postemergence herbicide applications either before cartons are removed or after trunks have had time to harden off after carton removal, to minimize the risk of herbicide damage.

Evaluation of Growing Degree Day Based Chemigation Treatments for Management of Branched Broomrape in California Processing Tomato Systems.

Matthew Fatino[1], M. Mesgaran[1,] B. Hanson[1]. [1] Department of Plant Sciences, University of California, Davis.

Recent detections of branched broomrape (*Phelipanche ramosa*) in California tomato fields has led to increased interest in herbicide treatment programs to control this regulated noxious weed. Broomrapes (*Phelipanche spp.)* are parasitic weeds that are a particular risk in California processing tomatoes for several reasons: 1) tomato has proven very vulnerable to broomrape in other regions, 2) broomrapes are likely to establish because of California's similar climate to their native range of the Middle East, 3) California has a wide range of alternate hosts for broomrape (carrot, sunflower, safflower), 4) broomrape produces copious amounts of minute seeds that are easily dispersed on machinery and through irrigation water, 5) high seed longevity, and 6) the major part of broomrape's lifespan occurs underground, making it inaccessible to conventional methods of weed control. A decision support system and herbicide treatment program, known as PICKIT, was developed over two decades of research in Israel, and has been proven to provide successful management of Egyptian broomrape (*P. aegyptiaca*) in tomato. The PICKIT system uses a thermal time model to forecast the belowground development of the parasite in order to precisely time the application of ALS inhibitor herbicides to target specific life stages of the parasite. Herbicide treatment programs based on the PICKET system were evaluated in 2019 for crop safety on processing tomato at the UC Plant Sciences Field Facility in an early- and late-planted experiment. These treatments included several combinations of preplant incorporated sulfosulfuron applications paired with different rates of imazapic either injected into the drip system or applied as foliar treatments. There were no significant differences in phytotoxicity or yield among herbicide treatments in either experiment, and after one field season, the PICKET decision support system seems to have reasonable crop safety on processing tomato under California conditions. This experiment will be repeated in 2020 at the UC Davis field site. If a commercial site infested with branched broomrape and a cooperating grower is identified, a similar experiment will be conducted in 2020 to evaluate the efficacy of these treatments. Additionally, a rotational crop study was initiated in a 2019 tomato field and will be planted back to crops commonly grown in rotation with tomato in this production region in order to evaluate the potential residual effects of these treatments. Together, these experiments will generate data necessary to support the registration of these products in California processing tomato if the problem with branched broomrape grows in magnitude.

Evaluation of Biofumigants in California Strawberry Nurseries.

Nelly Guerra, University of California Davis & Steven Fennimore, University of California, Davis

With increased restrictions on fumigant use and an uncertain future for the use of methyl bromide in California plant nurseries, as well as demand for plants using organic-compliant methods, alternatives to soil fumigants such as steam and biofumigants are needed. Nursery plant production has the highest possible phytosanitary standards and requires an integrated approach to control soilborne diseases and weeds in organic produced strawberry nursery plants in Northern California. From May to September 2019 our study focused on a high-elevated organic strawberry nursery located near Macdoel, California. The objective of this study was to compare the effects of methyl bromide, steam, anaerobic soil disinfestation (ASD), and Dominus, a biofumigant which contains allyl isothiocyanate. Data was recorded monthly on the number of runners and daughters produced by the strawberry plants, as well as weed emergence from the soil. The treatment that was most affective in decreasing weed seed viability was Dominus. The treatments that were the most affective in increasing daughter and runner growth was steam and ASD. This examination shows biofumigants can complement steam to control weeds and create higher strawberry yields, insuring a cost-effective organic fruit production.

Weed-Suppressing Cover Crops in Almond Orchards: A Research Update.
Steven C Haring*, Cynthia M Crézé, Amélie CM Gaudin, Bradley D Hanson. Department of Plant Sciences, University of California, Davis, CA 95616. *Presenting author contact: sharing@ucdavis.edu

Cover crops can create orchard understory vegetation that contributes to soil health, provides floral resources for pollinators, and potentially suppresses weeds. Cover crops can replace unwanted, resident vegetation by competing for light, water, and other resources. We planted two five-species mixes of cover crops in commercial almond orchards in Tehama, Merced, and Kern Counties in the fall of 2017 and again in the fall of 2018. A functionally-diverse cover crop mix contained two mustard, two legume, and one grass species, while the other mix contained five mustard species selected to promote pollinator health. We monitored orchard vegetation throughout the year with point-intercept transects. The experiment used a randomized complete block design with four replicates at each site. The presence of a winter cover crop reduced winter weed ground cover and winter weed community diversity compared to standard (i.e. no cover crop) treatments in certain cases. However, this effect was inconsistent across site-years. Higher levels of cover crop establishment generally improved weed suppression. Additionally, our functionally-diverse cover crop mix had generally better emergence compared to the other mix, though this effect may be related to planting rate differences between the mixes and did not necessarily reduce weed cover (instead reducing bare ground). We found no differences in late summer ground cover, suggesting that cover crop residue is not present around almond harvest time. Future research can help uncover the specific management factors that contribute to a competitive cover crop.

Understanding the Impact of Early Season Algae Infestation on Rice Seedling Emergence and Establishment. Guelta Laguerre [1], Sara Ohadi[1], JohMadsen[2], Liberty Galvin[1], Kassim Al-Khatib[1]
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Rice production in California has been challenged by the formation of nuisance algae in the beginning of the season. The early formation of algal mats is hypothesized to reduce the rice seedlings establishment; however, the extent of such reduction has not been investigated. Here we designed a controlled outdoor experiment to test how the algae infestation level would impact the rice seedling emergence and establishment. The experiment was conducted under semi-controlled conditions in Davis, CA from July through August of 2019. To simulate different algae infestation level (no algae, medium and high),15-gallon tubs filled with rice field soil were treated with various amount of fertilizers N: P including 0:0, 75:35 and 150:70 kg ha^{-1} prior to adding water. Sixty rice seeds (M206) were soaked for 24 hours and spread into tubs filled with water. Each algae infestation level had 10 replicates and the whole experiment were repeated three times. Water Temperature data was collected using Hobo data loggers. Emerged rice seedlings (i.e. when the rice is visibly broke the water surface) were counted every second day for five weeks. A Sample of water (50ml) was also collected from each replicates every week for chlorophyll *a* measurement. Photosynthetic active radiation (PAR) inside the water was measured every other day using a handheld PAR meter. A similar pattern of rice seedling emergence and establishment were observed across the three experiment runs. The results showed that the overall rice emergence declined by the increase of the chlorophyll *a* amount, which is to say the higher the algae infestation the lower the rice emergence. The Chlorophyll *a* amount of above 500 $ugml^{-1}$ could reduce rice seedling emergence by 90%. In addition, the rate of rice seedling emergence (time to 25% of emergence) was slower when there is high algae infestation. Our results show that uncontrolled algae could reduce rice stand by up to 90%. Given that algae infestation has a patchy pattern in the field, loss of rice stand in these patches could provide empty niches for other weeds to grow. Further studies, yet to be done to estimate how much algae could reduce the rice yield.

Characterizing Herbicide Resistance in Palmer Amaranth.

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Palmer amaranth is a dioecious C_4 annual weed from the family Amaranthaceae . Palmer amaranth is native to northern Mexico and the southwestern U.S. The species originally grew primarily in arid regions, and was consumed by Native American tribes. Palmer amaranth began to spread out of its native range in the early 20th century, possibly due to the spread of human activity. Agricultural expansion and seed transportation may have led to the species being introduced to suitable environments that were not originally spatially accessible. While the spread of Palmer amaranth was recognized in the early 20th century, the plant wasn't considered a serious agricultural pest until the late 1980's. As an agricultural pest, Palmer amaranth can make harvesting crops more difficult, decrease crop yields from 50 to 80 percent, and delay crop germination time. Due to continuous application and overuse of herbicides, populations of Palmer amaranth are strongly selected for herbicide resistance. Multiple-herbicide-resistant populations of Palmer amaranth have been discovered in several invaded Midwestern and Eastern U.S. states. Recently, populations of Palmer amaranth have been appearing throughout Central California in agricultural areas. It is important to determine whether these populations carry herbicide resistance genes to determine the most effective management strategies for Palmer amaranth. At least one California population is hypothesized to be resistant to glyphosate (the widely-used chemical RoundUp®) based on field trials. We also hypothesize that some populations in the native Southwestern range of Palmer amaranth may be independently developing herbicide resistance, because the species has been appearing more frequently in desert agricultural environments. To test these hypotheses, we are surveying a large number of populations from the Southwest and Central California for three different types of herbicide resistance, using both genetic and greenhouse assays.

Effects of Deep Seeding on Weed Management and Crop Response in California Rice Systems. **Alex Ceseski,** A. Godar, K. Al-Khatib, Department of Plant Sciences, University of California Davis, Davis, CA, USA

California rice (*Oryza sativa* L.) is grown as a monoculture, seeded by air into permanently-flooded basins. Decades of overreliance on a small number of herbicides have led to widespread herbicide resistance. The objectives of this study were to evaluate the weed management and crop physiology feasibilities of deep-drilled rice. Seeding deep should delay stand emergence and allow use of broad-spectrum herbicides on emerged weeds, without injuring the rice. This would make additional modes of action available for the mitigation of herbicide resistance. Seed of *cv.* M-206 and M-209 were dry-drilled to 3cm and 6cm, in a split-split-plot design with four herbicide programs, over 2018-2019. Herbicide programs centered on using glyphosate as a burndown treatment prior to rice emergence. Irrigation was by flushing every seven days until 28DAP, whereupon 10cm flood was established for the remainder of the season. Herbicides and required adjuvants were applied by CO_2-pressuized backpack sprayer with 8003VS flat-fan nozzles at 187 L ha^{-1}. Glyphosate was applied at 870g ae ha^{-1} just as rice was spiking. Glyphosate alone was able to control >60% of grasses and >80% of sedges. Treated plots were weed-free. Rice first-leaf tips died back after glyphosate application, but stands developed normally. Stands at 6cm planting decreased by 15.5% and 5.3% in 2018, but increased by 3.8% or were unchanged in 2019, for M-206 and M-209 respectively. Stand reductions were largely compensated for by increased tillering. Yields were not affected by 6cm depth for either *cv.* in 2018, while in 2019 they increased by 5% or decreased by 3.4% for M-206 and M-209, respectively. Yields compared to nearby water-seeded fields were 2-22% and 3-11% higher in 2018 and 2019, respectively. We found that excellent weed control and competitive yields are achievable with this program, given good scouting and field management.

Depleting Weed Seedbank Using Bio-solarization in Tomato Fields.

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Bio-solarization is a pest control tactics that combines the use of elevated temperature with amended organic matter and anaerobic conditions to create a lethal environment for weed seeds and other pests in the soil. A study was conducted in summer 2019 to evaluate the effects of different potential tomato-based organic amendments for bio-solarization on the viability of weed seeds [redroot pigweed (*Amaranthus retroflexus)*, common lambsquarters (*Chenopodium album*), and field bindweed (*Convolvulus arvensis*)] in a tomato field. Treatments included incorporated late-season tomato plant debris covered with tarp (OBS) or without tarp (ONT), tomato pomace of 2.5% w/w amendment covered with tarp (TPBS) or without tarp (TPNT), young tomato plant debris covered with tarp (YBS) or without tarp (YNT), as well as a no organic amendment treatment with tarp (CBS) or without tarp (CNT, as control). The tomato pomace was spread on the soil surface and the tomato plants were first flail mowed before all plots were mechanically incorporated to a depth of 5 cm with a rototiller. Individual plots were 1.5 m wide and 3.7 m long and each treatment was replicated six times. Weed seeds were buried following incorporation of plant debris, prior to plastic tarp installation. For each weed species, there were 2 cloth bags (~ 0.3 litre in size) containing 100 seeds each, buried in a depth of about 5 cm in each plot. The buried seeds were collected after two weeks for viability test. In general, our results suggested that bio-solarization partially killed the evaluated weeds seeds under these conditions; the level of mortality varied with the type of organic amendment, and weed species. Treatments with organic amendments (with exception of TPNT) provided greater weed seed mortality (36 to 50%) compared to those without organic amendments (18 to 29%), averaged across weed species. The greatest weed seed mortality was provided by bio-solarization that utilized the late-season tomato plant as organic amendment (OBS); which caused up to 65% seed mortality of redroot pigweed. The OBS provided 44 and 42% seed mortality of common lambsquarters and field bindweed respectively, however, these were not different from mortality provided by TPBS and YBS. By implication, this study suggested that bio-solarization can be used to deplete weed seedbank using tomato-based organic amendment, thereby reducing weed pressure in the following crops in a tomato field.

Vineyard Weed Management: What To Do When the Winery Says "No Glyphosate" John Roncoroni, UCCE, Napa County

The wine industry is consumer driven. Unlike many of our agricultural crops winegrapes are not the finished product, they must be processed into wine. Brand loyalty is very important to the wine industry. Other crops such as walnuts and almonds are sold as a commodity and with few exceptions have little brand loyalty. While a preponderance of the science has shown that glyphosate is a safe pesticide many customers are asking for wines from glyphosate-free vineyards.

Most consumers don't understand the need for weed management in vineyards. Pathogens, vertebrate pests, water use and harvest costs may be increased by poor weed control. Weeds can be controlled in many ways that do not include glyphosate. Costs, at least initially, will increase without glyphosate. How will the industry deal with these new increased costs? Wine positioned in the "premium" or "super-premium" category will be able to absorb these new costs and, in fact, may already be using alternative weed control methods. What about the moderately priced or "budget" wines? Will the consumer accept an increased price for these wines? Will they give up these wines for alternatives such as hard seltzers or cannabis? Will the winery pay for the increased cost of weed control and absorb the cost while keeping the consumers price low? Will there no longer be a market for these wines or the grapes used to produce them?

Glyphosate has been an important tool for weed control in the winegrape industry for decades because it's safe, effective and cheap. There always have been alternatives to glyphosate but no one method or chemical can compare in all three areas. Pest management budgets vary among vineyards. From my experience the priorities are usually: 1. pathogens; 2. insects; 3. weeds. In years when disease or insect pressure is high growers have been able to balance their pest management budget by reducing their weed control budget with what I have referred to as "The Hammer"- glyphosate. If it rains too much to get the cultivator in a grower usually can get in with "The Hammer." Or when it doesn't rain enough to incorporate preemergence herbicide "The Hammer" will work.

So, what do you do when the winery says, "No glyphosate?" Over reliance on any one tool has its consequences and the industry's dependence on glyphosate has had repercussions. We have had to deal with herbicide resistance for several years now, but maybe more than anything this dependence on glyphosate has stifled research, innovation and, most importantly, acceptance of alternative methods of weed management. Proper identification and an understanding of weed biology is even more important now that "The Hammer" may not be available as a tool. An integrated approach has always been an important, if not widely accepted, strategy for weed management. Recently many new innovations are being tested for vineyard weed mangement. Cultivation, flaming, grazing, and organic and alternative herbicides will be an increasingly important part of growing winegrapes in California. Implementing IPM for weeds and knowing when and how to properly use these tools are imperative.

Under-Vine Mechanical Weed Control. Marcelo L Moretti, Department of Horticulture, Oregon State University, Corvallis, OR 97331.

Vineyard under-vine weed management relies on herbicides, especially glyphosate. Glyphosate use, once deemed sustainable and safe, is now jeopardized by glyphosate-resistant weeds, and public opinion leading vineyard managers to seek an alternative to herbicides. Mechanical under-vine weed control implements are viable alternative for growers; an array of types and price points is commercially available. However, the adoption of these implements lags compared to herbicide use. Under-vine cultivators' performance, costs, and applications have not been well-documented. The objective of this study was to evaluate the efficacy of under-vine implements. Two on-farm field studies were conducted in 2019 in commercial vineyards in western Oregon. The first study, in Salem, OR, began in late March 2019. The most common weeds present at that time were dove-foot geranium, cat's ear, and hare barley. Rainfall occurred within two days after the initial treatment and continued intermittently for the following two weeks. The second study, in Yamhill, OR, began in early May 2019. The most common weed species present were fine fescue, white clover, dove foot geranium, and soft brome. No rainfall occurred after the experiment was initiated. Both experimental units were on coarse-loamy soils, rows were spaced 7-ft apart, and the soil was moist at the time of treatment. The implements evaluated were blade-hoe, rotary hoe, blade-hoe combined with a rotary hoe, a brush weeder, and a blade mower. A nontreated was include for comparison. Each treatment was applied to both sides of the vineyard row. All implements were propelled by a hydraulic pump mounted behind a 20 hp narrow tractor. The experimental design was a randomized complete block design with four replicates. Each experimental plot consisted of an entire row with at least 60 vines per plot. Seven sub-plots of 10 ft in length with uniform weed presence were selected for evaluation at the begging of the experiments. Assessments, made four-weeks after treatment, included visual estimates of weed control in a scale of 0 to 100% representing no control and complete control, respectively. Above ground weed biomass was collected, dried, and recorded. Data were analyzed separately using analysis of variance procedures; means were separated using Tukey's test.

Weed control efficacy across all implements was 30% or less in the Salem experiment, compared to up to 70% in the Yamhill experiment. The continuous rainfall after the experiment favored weed regrowth, and confounded weed control. In the Salem experiment, the greatest weed control was observed with the blade, blade plus rotary hoe, and the brush weeder (28 to 30% control). The rotary hoe used alone, or the mower were not different from the nontreated plots. High soil water content limited rotary hoe efficacy because the soil did attach to the implement, hindering the uprooting of weeds. The weeds were smaller than the mower could effectively treat. Despite poor efficacy, the blade and the blade plus rotary hoe reduced weed biomass by 75% and 25% relative to untreated plots, respectively. In the Yamhill experiment, the blade plus the rotary hoe provided 70% weed control. The blade hoe provided 45% weed control, and the rotary hoe, brush weeder, and mower provided 20% weed control. All treatments reduced weed biomass relative to untreated plots. The blade plus rotary hoe reduced weed biomass by 66% compared to untreated plots.

This study demonstrated that blade hoe plus rotary hoe is an effective implement for weed control in late winter and spring in vineyards. However, rainfall events occurring after treatment can reduce efficacy of these implements. Rotary hoe and brush weeder efficacy in this study may have been compromised by the tractor output. Despite the hydraulic power pump, the tractor could not sustain the proper speed and torque required for the optimal implement functioning. Furthermore, the study was limited to late winter and early spring. One can anticipate that implement performance depends on soil moisture content and weather conditions. This project, funded by Western SARE, will continue for the 2020 season.

Phenoxy Herbicide Issues in Tree and Vine Crops: Relative Risks and a Few Opportunities. Brad Hanson, University of California, Davis

The California orchard and vineyard crop sector is dominated by nearly 2 million acres of tree nuts and just under 1 million acres of grapes but also includes dozens of other perennial fruit crops that collectively cover close to another million acres. Although this crop sector is diverse, available herbicide modes of action are somewhat limited in what is registered and further limited by what is used in practice. To use 2016 tree nut herbicide use as one example, the PPO-inhibiting herbicides and glyphosate (EPSPS inhibitor) were each applied to just over 2.2 million acres. In that same year, the next four most widely used modes of action [PSI inhibitors (e.g. paraquat), glutamine synthetase inhibitors (e.g. glufosinate), ALS inhibitors (e.g. rimsulfuron), and mitotic inhibitors (e.g. pendimethalin)] were collectively used on only 2.1 million acres of tree nuts. By comparison, the phenoxy or auxin mimic herbicides (e.g. 2,4-D) were used on just over 100,000 acres of tree nuts that year.

There is some interest in revisiting the opportunities (as well as risks) of phenoxy herbicides in California orchard and vineyard crops. First, glyphosate-resistant weeds in agronomic cropping systems in other states have led to the development of crop cultivars resistant to phenoxy herbicides (mostly 2,4-D and dicamba associated traits). This, in turn, has led to renewed interest and some cases reformulation of those herbicides. Currently, 2,4-D is the only synthetic auxin with any registrations in tree and vine crops in California and use has been relatively low but steady over the past three decades.

Why might there be new opportunities for phenoxy herbicides in California trees and vines? First, herbicide-resistant (glyphosate- and to a lesser extent paraquat-resistant) broadleaf species such as hairy fleabane and horseweed remain important across the Central Valley. Postemergence herbicide options with different modes of action can help manage these problems. Second, and more importantly currently, some tree crop growers and industries have concerns about the viability of glyphosate-dependent production systems due consumer and market pressures related to perceived human health risks of glyphosate. Setting aside the health concerns, if glyphosate becomes a less-viable options, phenoxy herbicides receive renewed interest as one of the few translocated herbicide classes with the potential to control larger broadleaf weeds, perennial species such as field bindweed or alkaliweed. Additionally, with increasing interest in cover crops in orchards, there may be opportunities for selective weed control in grass or cereal intercrops.

What about those risks? The primary reason that phenoxy herbicide, which are fairly low cost and effective, are not more widely used in trees and vines is the risk of crop injury. Perennial crops can be injured by phenoxy herbicide drift, volatility, or root uptake from the soil. Some of the newer formulations of these herbicides, such as 2,4-D choline, are much less volatile that 2,4-D ester and amine formulations so movement as vapor is reportedly much reduced. However, spray droplet drift remains largely a function of local conditions and operator choices and these risks remain. Similarly, once in the soil, risks are similar to older formulations. While phenoxy herbicides currently registered or with potential in orchards tend to have relatively short half-lives, they are also quite water soluble and only moderately bound to soil and risk of crop response would be higher in coarse soils compared to fine-textured soils. Lastly, phenoxy herbicides applied to immature bark of younger trees, to suckers, or to shallowly rooted tree crops would be likely to have some crop safety risks.

Because of the potential risks, which vary to some degree among tree and vine crops, phenoxy herbicides are not likely to become dominant in this crop sector in California. However, this class of herbicides does bring some unique attributes (particularly being translocated and with efficacy on perennial broadleaf plants) and may become more important tools in the weed control toolbox. The old saying "what's old becomes new again" sometimes applies in unexpected ways; phenoxy herbicides, some of which have been registered for decades, may see increased consideration by tree and vine growers if other cornerstone herbicides become limited by regulation or market forces.

Influence of Increases of Non-Managed Fallow Areas on Insect Pest and Disease Pressures. T. A. Turini - University of California Ag and Natural Resources Veg

Fallow non-cultivated land harbors a mixture of plant species that host pathogens and providing habitats for insects. These areas are likely to negatively impact crops grown in the region. Climate, cropping patterns and practices as well as the character, history and size of the fallowed area will influence species present, pest harbored and the nature of the crop impacts. An example of a hazard in the Central San Joaquin Valley includes the weed hosts of viruses and associated insect vectors. *Beet curly top virus* (BCTV) and the beet leafhopper vector that may occur in fallowed land. The issue of plant-resistance breaking *Tomato spotted wilt virus* (TSWV) first reported in 2017 in Fresno County and the detection of this recently reported strain in winter weeds is a major concern. Furthermore, silverleaf whitefly, which only recently has become a major concern in vegetable crops in Central California also may overwinter in weedy areas. These insects may transmit viruses not currently known to be present in this production area but are reported in warmer portions of the state. Other insects, such as stink bug species, that can inflict direct damage on our crops can also build in unmanaged areas. Other risks including those of air-borne pathogens that can survive on vegetation likely to be present in fallow fields.

Although, host ranges are broad for many of the issues of concern, specific plants pose greater risks. In the case of BCTV, *Bassia spp.*, *Kochia spp.* and Russian thistle *(Salsola tragus)* are among the most common summer/fall hosts. Plants that most commonly support the leafhopper and virus during the winter include Plantago spp., Filarees and perennial pepperweed. Although the greater risk has been from habitats in the foothills west of the San Joaquin Valley, overwintering populations on the valley floor and increased fallow ground increases the risk of this occurrence. While thrips and TSWV overwintering sites are commonly associated with Asteracea hosts, prickly lettuce (Lactuca serriola) and Sowthistle (Sonchus spp.); there are hundreds of hosts reported. In addition, the plant resistance-breaking strain of this virus was detected in these weeds.

If multiple years of fallow result, the heavy cover may provide an overwintering site for Consperse stink bug. This insect has inflicted damage on processing tomatoes in the region and it is likely that this will increase with increases in overwintering habitat. From the overwintering site, this insect may then move onto weeds, including black mustard in early spring where reproduction may occur before then moving into crops in later spring and summer.

Risk associated with a large increase in field fallowing may be mitigated with considerable effort. Management changes will be required by planning crop rotations, surrounding crops and by timing any sanitation efforts made. Tillage or treatment of a weedy area with herbicide, if infested by problematic insect species should be conducted when crop hosts are not present, or insecticide treatment of the area may be considered. As the regional landscapes change, risks due to pests are also altered.

Alternatives to Glyphosate for Non-Selective Weed Control. Barry Tickes, Cooperative Extension, University of Arizona

Glyphosate has long been a popular product for non-selective weed control around fields. It is an effective treatment and the regulations for this use are reasonable. There has been much public concern in recent years, however, about the safety of this herbicide to human health. Some countries and U.S. municipalities now have strict regulations for Glyphosate use. Whether they are warrened or not, these concerns have caused growers to look for alternatives.

Glyphosate is popular for use around fields because it is 1) broad spectrum and will kill both grasses and broadleaf weeds, 2) is not active in the soil and will not wash into fields, 3) is not volatile and with not lift off and move into fields and 4) is affordable even in low value crops.

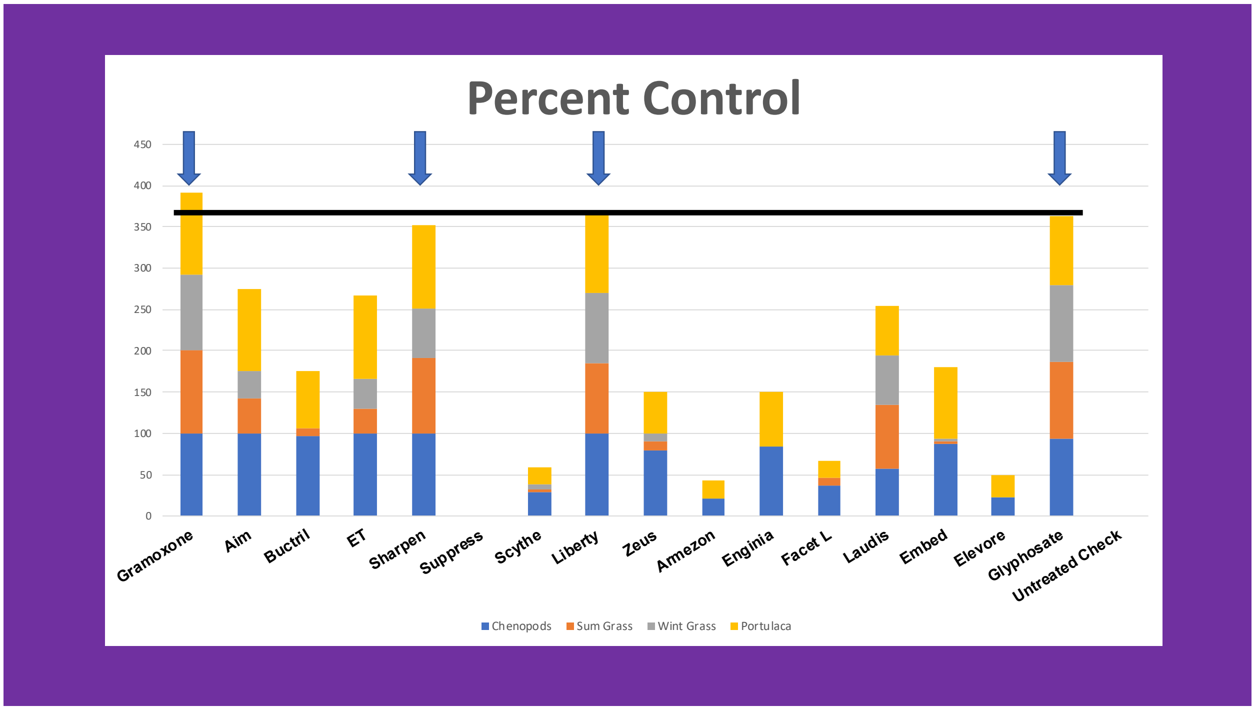
We evaluated 15 herbicides this season to determine how well they would fit these criteria. These included herbicides that used 5 different modes of action to kill weeds . The trials were conducted between October and December this year at the Yuma Agriculture Center. The herbicides that were tested and their mode of action are listed in the table below.

Cell Membrane Disruptors	Plant Growth Regulators	Photosynthesis Inhibitors
Paraquat	2,4-D	Bromoxynil
Carfentrazone	Dicamba	
Pyraflufen	Arylex	
Caprylic acid	Quinclorac	
Pelargonic acid		
Saflufenacil		
Sulfentrazone		

Protein Synthesis Inhibitors	Pigment Inhibitors
Glufosinate	Tembotrione
Topramezone	

Weed Control

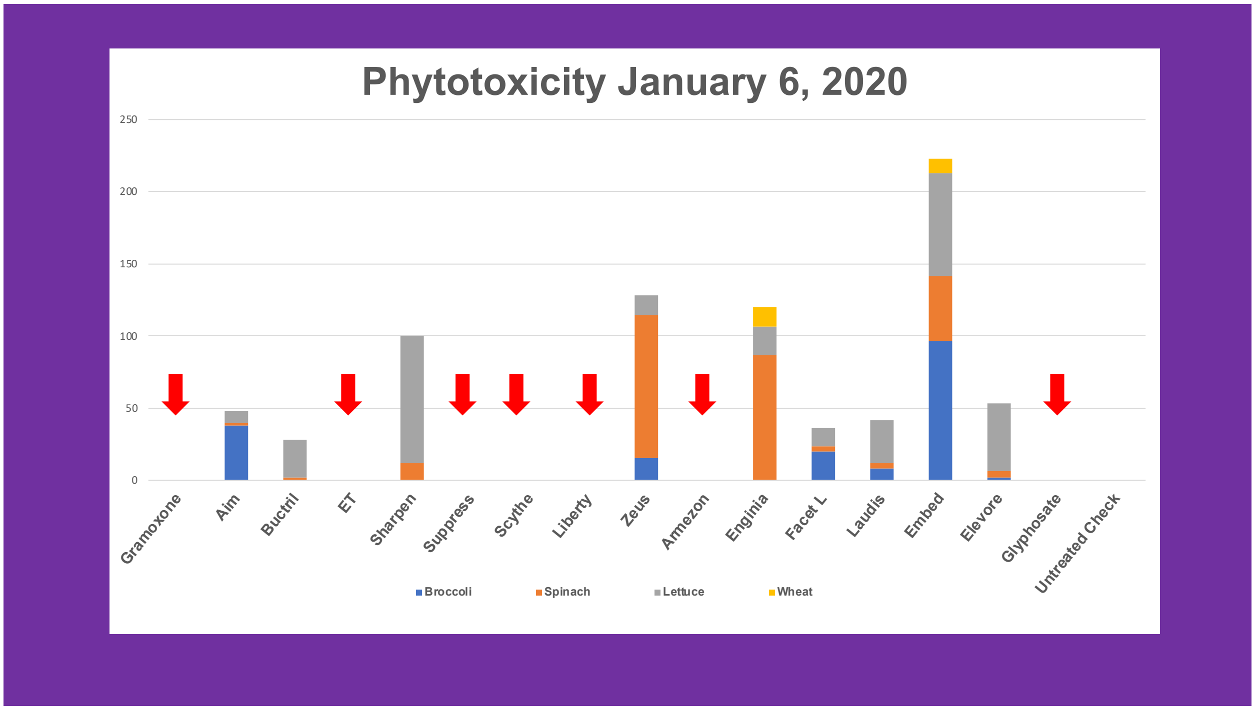
The weeds that were present in these trials were nettleleaf goosefoot, lambsquarters,common purslane, summer annual grasses and winter annual grasses. The following graph illustrates the levels of control we achieved with these weeds compared to Glyphosate.



There were only 3 of the tested products that controlled all of these weeds as well as Glyphosate (arrows). These were Paraquat (Gramoxone), Salflufenacil(Sharpen) and Glufosinate(Liberty,Rely). Several of the others were good on broadleaves but weak on grasses. This could be overcome by combining them with a grass herbicide.

Soil Residual

One of the characteristics of Glyphosate that make it so popular is that it does not stay around in the soil except in very rare situations. Soil gets moved around with equipment,wind and water and soil activity can be a negative even on field edges. Soil residual herbicides are commonly used here but most have fairly short activity. We planted wheat, lettuce, broccoli and spinach into plots that we had treated with the 15 herbicides we evaluated. Four of them injured at least one of the crops. These were 2,4-D choline (Embed), Dicamba (Enginia),Sujlfentrazone+Carfentrazone (Zeus) Carfentrazone(Aim,Shark).



In terms of broad spectrum weed control with no soil activity, only two of the fifteen herbicides we evaluated were comparable to Glyohosate. It is likely that a combination of a grass and broadleaf herbicides will be necessary.

Caltrans Weed Management in ROW and Landscape. William Nantt, Caltrans

California is a unique state from a national perspective. We possess the nations highest population, the biggest economy, the greatest number of vehicles and we're facing some of the most difficult issues. With vast natural resources and huge tax base we still struggle providing even the most basic services you'd expect from a state of this stature.

Even though many of our problems stem from natural disasters, just as many are self-inflicted. Political decisions are often made with national recognition or legacy building in mind versus basic governance. Political decisions made decades ago have repercussions today. Speaking from a transportation vegetation management perspective I deal with these decisions on a regular basis.

In 1992 Caltrans was under pressure from various anti pesticide groups which resulted in the agency deciding to contract with a vendor to produce the Environmental Impact Report of 1992. The essence of the EIR was that we as an agency would adopt an IVM approach to vegetation management with an 80% reduction in herbicide use by 2012 and a reduced number of acres touched by any means. This suggestion was made with the statement that this would be done only in the roadside portion of our program and only include herbicides and surfactants. In addition, the document included the caveat that this would be done only if resources allowed.

The resulting management decision to also include the landscape program, tree program and rest area programs in the reduction as well as including insecticides, fungicides and rodenticides was one of those mistakes that reverberate today.

Two acute issues we face today are the plethora of enormous, seemingly uncontrollable wildfires and the ever-increasing homeless population. Bureaucracies are notoriously slow to react to threats and these two are no exception. These issues intersect when homeless camps provide conditions favorable to wildfire ignition.

The decisions of 1992 have contributed to todays conditions in the form of increased fuel load adjacent to our highways and providing shelter for the homeless in environmentally sensitive areas in the form of perennial weeds we aren't allowed to manage.

Caltrans also faces staffing and training issues due to current socioeconomic conditions in our urban centers. Our workers when, we can get them, come from many other countries and often speak English as a second language. In addition, there are cultural and values differences that come into play. Training our workforce and retaining them is difficult. Caltrans encourages our pesticide handlers to get application certified through the DPR process. The testing failure rate for our employees is over 80 percent. I believe we must recognize that the traditional way of training and testing is failing and we must find a way to serve the workforce as it exists today.

TerraVue™: A New Herbicide for Non-Crop Land Management.

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TerraVue™ is a new herbicide developed by Corteva Agriscience for control of broadleaf weeds, including invasive and noxious weeds, and certain woody plants. TerraVue™ represents an innovative new tool that is a non-ester, non 2,4-D containing, low odor, low use rate formulation that provides postemergence and preemergence residual control of susceptible broadleaf plants and seedlings, and some woody plants. It will provide control of all species controlled by Milestone® herbicide, plus many additional species and offers flexibly in application (ground, aerial, broadcast, or spot treatment). A key component of TerraVue™ is Rinskor™ active, a novel new active ingredient in non-crop sites, and is an EPA Reduced Risk Pesticide. In trials over multiple years across the United States, TerraVue™ provided excellent control of weeds such as yellow starthistle (*Centaurea solstitialis*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), wild carrot (*Daucus carota),* Purple loosestrife (*Lythrum salicaria*), squarrose knapweed (*Centaurea squarrosa*), spotted knapweed (*Centaurea maculosa*), poison hemlock (*Conium maculatum*), common caraway (*Carum carvi*), and many more. Preemergence trials conducted in 2019 showed that TerraVue™ provided excellent control of Russian thistle (*Salsola tragus*) and other western broadleaf weeds. Broadleaf weed control was increased, and excellent grass control was achieved when tank mixing with CleanTraxx® Herbicide. Based on these efficacy data, it is anticipated that TerraVue™ will be a very useful weed management tool in non-crop and other sites.

Consideration of Options and Alternatives for Weed Control. Kai Umeda, University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040. kumeda@email.arizona.edu

There are options for alternative methods of weed control in addition to the common default use of herbicides. Chemicals are not and should not be relied upon as the sole weed control method. An integrated approach should take into consideration economic, environmental, and human health concerns without having to depend solely on a single tactic. An integrated weed management system is desirable by taking advantage of knowledge and proven techniques that are safe, simple, and affordable. Three strategic methods for weed control are biological, cultural, and chemical. Biological control takes advantage of natural enemies of weeds such as animals, insects, or diseases. Cultural control methods and techniques are practices that can be implemented to prevent weeds from appearing in a location, manipulating the environment to give the desired plants in a landscape more of an advantage to flourish over a weed, or physically remove the undesirable weed. Chemical weed control utilizes herbicides to eliminate undesirable weeds selectively or in a broadspectrum fashion.

Biological control in many cases utilizes animals such as goats or sheep that can be herded and introduced to a weedy site to graze and remove the weeds. Geese can be similarly introduced to an area to remove undesirable vegetation. Microbial diseases including fungi, bacteria, viruses, or nematodes may be naturally occurring or may be artificially introduced to a site to infect susceptible weeds. Diseases require the “disease triangle” of the host weed being present at the susceptible stage and condition, the pathogen being introduced artificially or already naturally occurring to be able to infect the weed, and the environmental conditions having the right temperature, moisture, etc. Biocontrol agents can be insects or mites that invade and feed on a weed’s roots, shoots, flower, or seed. The immature or adult stages of the insects may have preferences for certain parts of the weed as it grows.

Cultural methods are all practices other than biological or chemical. Preventive practices restrict the movement of weed seed or propagules. Humans and animals ship or transport seeds, stolons, rhizomes, sprigs, or other vegetative plant parts from location to location where highly adaptive weeds can get established rapidly. State and federal laws and regulations restrict movement within and between states. Seed laws restrict movement of weed seeds in commercial crop seed sales. Preventing weeds can be achieved by manipulating planting time and techniques to give an advantage to crops and landscapes so weeds emerge earlier or later to not become competitive. Monitoring or scouting the site to observe and identify weed species and recording them as to the location and time of emergence and growth stages will provide a record of occurrence(s) and help to develop a weed management program. Mechanical practices include hand-pulling, hoeing, mowing, and tilling or cultivating to remove weeds. Such practices should be done to prevent the weed from flowering and then setting seed before they can be disseminated. Use weed identification guides such as the 2-volume “Weeds of California and Other Western States” or if you can be lucky, find a copy of the out-of-print “Weeds of the West”. After identifying whether the weed is an annual or perennial, grass or broadleaved weed, winter or summer, keep accurate records of the infestation for where it occurs, time of the year that it emerges, flowers, or dies. Use mowing, hoeing, or weed-whacking when weeds are small and easy to physically remove. Mow low and frequently if weeds become too large and too late for spraying. In turf, mowing height of cut and frequency can encourage or discourage weeds. Weak turf mowed too short can create voids for weeds to invade and emerge. Tall turfgrasses can create a canopy and shade out weeds as they try to become established. Frequent mowing can weaken weeds against the competitive turf that develops a dense canopy. Less frequent mowing can allow weeds to grow above the turf and mature to set seeds. Cultivation practices that slice, verticut (vertical mowing), or punch holes or remove cores to aerify improve the health and vigor of the turfgrass by providing air and water for the roots. Physical barriers with plastic sheets or other natural products (wood chips, paper sheets, organic mulch materials) can cover and smother surfaces to prevent weed emergence and establishment. Walls and physical barriers or layers of rocks or gravel or organic mulches can prevent weed encroachment. Preventing or eliminating excessive moisture (i.e. leaky irrigation systems) will prevent weed seed germination and weed invasions. Another mechanical weed control practice is to use steam or flame. High heat can be used to ”cook” small weeds.

Selective or broadspectrum chemical applications can be done safely to control weeds in turf or in areas where total vegetation control is desired. Applicators should always read and follow product label instructions and use and wear required personal protective equipment – long-sleeved shirts, long pants, socks and shoes, eye protection, and rubber gloves at a minimum. Spot-sprays can selectively control small concentrated populations of weeds scattered over an area while a boom sprayer can cover larger acreages more efficiently, A very selective application technique can be to “wipe” a differentially taller weed growing above the turf . Granular herbicides can be spread across a site to provide control preemergence or ”weed and feed” with a postemergence herbicide-coated fertilizer. Selective herbicides control specific weeds within a desirable crop or landscape without causing injury or damage to desirable turfgrass or trees and ornamentals. They “select” the weeds to control. Some herbicides can select a broadleaved weed out of the turfgrass or control weedy bermudagrass in an ornamental shrub.

A preemergence herbicide is applied to the soil or turf before the weed seed germinates. It is absorbed by the tiny root or shoot that first emerges from the seed and doesn’t allow it to grow. Newer chemistries are now applied at low doses weighed out in ounces compared to many older products that required several pounds per acre or per 1000 sq ft per label instructions. For turfgrasses, many winter and summer annual broadleaved weeds can be effectively controlled postemergence with the synthetic auxin (2,4-D related) family of herbicides. These herbicides applied to the foliage enter the plant and mimic the naturally occurring plant hormones within the weeds and the overdose causes the leaves and stems to grow uncontrollably exhibiting twisting, strapping, and becoming mis-shaped before dying. Caution should be used and the labels read and followed to avoid spray drift to non-target desirable and sensitive crops and ornamentals. There selective “fops and dims” that effectively control only grassy weeds when applied to the foliage. Fluazifop (Fusilade), sethoxydim (Segment), and clethodim (Envoy) are very effective against weedy bermudagrass in landscapes.

Glyphosate (Roundup and many other branded products) is one of the most popular, safest, and effective general herbicides available in the marketplace. It is not selective as it is effective against a broadspectrum of annual, perennial, grassy, and broadleaved weeds. It must be applied to the foliage of the weeds as it is not active in the soil as a preemergence herbicide. As mentioned, there are many products with different brand names that contain glyphosate. However, the efficacy of the different products may vary when they may be manufactured or reformulated by different manufacturers. Very confusing marketing of the Roundup name is occurring as homeowner products are labeled as “Roundup” for lawns that do not contain glyphosate but other active ingredient herbicides that do selectively control turf weeds. There are other glyphosate formulated products that include active ingredients to enhance and improve the rapidity of herbicide symptoms on weeds. Adding diquat herbicide to glyphosate in the pre-mix product exhibits faster leaf burning symptoms compared to slower yellowing by glyphosate alone on foliage. Further confusion for the end-user is the addition of herbicides that offer extended residual weed control for months compared to glyphosate alone that does not last at all. Potent herbicide active ingredients such as imazapyr or imazapic last long for bare ground weed control and can severely damage nearby trees and ornamentals when sprayed near roots. Otherwise, glyphosate products are safe and effective tools for economical weed control.

Glufosinate (Finale) is similar to glyphosate in that it is non-selective against most grass and broadleaved weeds as a postemergence spray. The formulated product doesn’t contain a high concentration of active ingredient so more product is required to be mixed in the spray tank. Compared to most highly safe glyphosate products, Finale has a ‘Warning’ signal word to protect eyes from potential harm and damage. Diquat is relatively safer to use than its related paraquat herbicide. Immediate results can be observed when diquat herbicide burns foliage of treated weeds. It is most effective against small grasses and broadleaved weeds. Very similar to diquat, immediate results can be observed when Scythe herbicide burns foliage of treated weeds. It is most effective against small grasses and broadleaved weeds. It is a long-chain fatty acid – pelargonic acid. It, too, has the signal word is “Warning” because it is a hazard to eyes. Very similar to diquat and Scythe, immediate results can be observed when Prizefighter herbicide, another long-chain fatty acid – nonanoic acid, burns foliage of treated weeds. It is most effective against small grasses and broadleaved weeds. It also has a ”Warning” signal word and additionally, it is listed as an organic pesticide. A “home brewed” herbicide consisting of vinegar, salt, and soap offers some control of small weeds similar to diquat, pelargonic acid, or nonanoic acid herbicides. The acetic acid content in cooking vinegar is much less concentrated than industrial strength material that is 20%. Mixing and spraying a ”home brewed” herbicide is hazardous so at a minimum, eye protection must be worn when using an acid, soap, and salt spray. The commercial use of such a ”home brewed” herbicide is not legal. Very similar to diquat, pelargonic acid, and nonanoic acid herbicides, immediate results can be observed when citric acid or clove oil derived herbicides burn foliage of treated weeds. They are most effective against small grasses and broadleaved weeds. Weed Slayer is a relatively safe product with a “Caution” signal word. BurnOut can cause eye irritation and harmful if swallowed so it has a “Danger” signal word.

For desert turf, when bermudagrasses are dormant during the winter season, non-selective herbicides can be applied to control most winter annual weeds. The contact herbicides can be used safely during most of the winter and multiple applications may be required if weeds are too big and not completely controlled during the cold weather. Systemic glyphosate should be applied only when no green tissue can be seen on the bermudagrass. With warmer temperatures and spring approaching, bermudagrass begins to greenup and any glyphosate contact may delay spring transition. When the bermudagrass is dormant and "blonde", turf colorants can be used to enhance the color to mimic winter ryegrass overseeding and to allow the use of non-selective herbicides.

A last resort to maintain green surfaces is to install synthetic turf, it will still require water for cooling and cleaning as well as regular maintenance activities to groom it and maintain its upright quality and the proper in-fill depth and uniformity. Weeds can still penetrate the backing material and emerge as nutsedge does or annual weed seeds can germinate and grow in the in-fill material.

Many options have been presented for weed control in an integrated manner and there are alternatives available without being dependent upon a single tactic or sole herbicide product.

*Product names mentioned are registered trademarks. Any products, services, or organizations that are mentioned, shown, or indirectly implied in this publication do not imply endorsement by The University of Arizona.

Alternatives to Glyphosate: Efficacy and Trade-offs in the Landscape.

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Urban land managers who serve schools, municipalities, and other organizations are increasingly developing or changing their IPM policies and plans to use organic herbicides for weed control. The general public's concern over glyphosate and other conventional herbicide use in parks, public spaces, schools, and other landscapes is largely the driver for this change. In response, many practitioners are looking for alternatives for reducing or eliminating the use of glyphosate and other synthetic herbicides.

Unlike glyphosate, products in these trials work as contact, burn-down herbicides. The active ingredients and products included in our trials were caprylic acid/capric acid (Suppress), herbicidal soap (Finalsan), clove oil/cinnamon oil (WeedZap), citric acid/clove oil (Burnout II), pelargonic acid and fatty acid (Scythe), ammonium nonanoate (AXXE), d-limonene (Avenger), Fiesta (iron HEDTA), Weed Slayer, glufosinate (Finale), glyphosate (Ranger Pro), and an untreated control. Results of our limited trials indicate these contact herbicides do not provide sustained weed control and weeds grow back after 2 to 3 weeks.

Shifting to non-glyphosate products will involve adjustments to how and when alternative herbicides are used and other trade-offs. There will be more frequent applications needed at higher product volumes, increased costs for labor involved in more frequent applications, possible increased costs in purchasing additional personal protective equipment (PPE), training for handling more acutely toxic products, and higher product costs. We are continuing to research these products in varying conditions so we can understand more about how alternative herbicides can best fit into landscape IPM programs.

Bermudagrass Response to Organic and Glyphosate-containing Herbicides.

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Introduction

There is contemporary interest in reducing maintained turfgrass and converting urban landscapes to native or naturalized vegetation. One of the most important elements of a lawn renovation is termination of existing vegetation, and consumers are looking for weed control approaches without conventional herbicides. Bermudagrass is a popular turfgrass for California lawns and was selected as the target turfgrass species in this experiment. At present, the industry standards for bermudagrass control are glyphosate (Roundup) and fluazifop (Fusilade II).

Objective

The objective of this research was to compare bermudagrass turfgrass response to conventional and organic herbicides.

Methods

This experiment was conducted on an area of 'TifSport' hybrid bermudagrass (*Cynodon dactylon* × *C. transvaalensis*) located at Ridge Creek Golf Course in Dinuba, California. The hybrid bermudagrass sward was maintained as a lawn or golf course rough, mowed weekly at 1.75 inches and irrigated to prevent drought stress.

Herbicide treatment plots were 5x5 ft^2 and arranged as a randomized complete block with 4 replications. Treatments included 5 organic herbicides, 2 conventional herbicides, mechanical sod removal (data not discussed), solarization (data not discussed), and an untreated control (Table 1). Herbicide treatments were broadcast sprayed with a CO_2-pressurized backpack sprayer and a water carrier volume of 100 gal/acre. Applications were made 31 July 2019, at 12:00 PM with 0% cloud cover and air temperature approximately 90ºF.

Trade name	Active ingredient	Percentage active ingredient in product	Application rate[1]
Avenger	d-limonene	70%	25% v/v solution
Burnout	Citric acid + clove oil	8% + 2%	25% v/v solution
Finalsan	Ammoniated soap of fatty acids	22%	17% v/v solution
Suppress[2]	Caprylic acid + capric acid	47% + 32%	9% v/v solution
WeedPharm	Acetic acid	20%	100% solution (no dilution)
Ranger PRO[3]	Glyphosate	41%	5 qt/acre (1.25% v/v solution)
Ranger PRO + Fusilade II[3]	Glyphosate + fluazifop	41% + 24.5%	5 qt/acre + 24 fl oz/acre

[1]v/v = volume/volume; qt = quart; fl oz = fluid ounce

[2]An acidifier (BioLink) was added at a rate of 1% volume/volume solution

[3]A nonionic surfactant (Prefer 90) was added at a rate of 0.25% volume/volume solution

Table 1. Herbicide trade names, active ingredients, and rates.

Bermudagrass control was measured with normalized difference vegetation index (NDVI), collected with a handheld sensor. Lower values mean less green turfgrass (more bermudagrass injury). Higher values mean more green turfgrass (less bermudagrass injury). Dunnett's test was conducted compare herbicide differences from the untreated control for each date.

Results

<u>Conventional herbicides:</u>

Significant injury was observed in glyphosate (Ranger PRO) and glyphosate + fluazifop (Ranger PRO + Fusilade II) plots at 5 days after treatment (DAT). The glyphosate-containing treatments maintained significant injury throughout the duration of data collection, up to 42 DAT (Figure 1).

<u>Organic herbicides:</u>

Herbicides d-limonene (Avenger), Finalsan (ammoniated soap of fatty acids), caprylic acid + capric acid (Suppress), and acetic acid (WeedPharm) showed significant injury 2 days after treatment (DAT) compared to untreated control plots. Suppress and Finalsan plots recovered by 19 DAT, while Avenger and WeedPharm plots recovered by 28 DAT. Throughout the entire trial, Burnout induced no injury compared to controls.

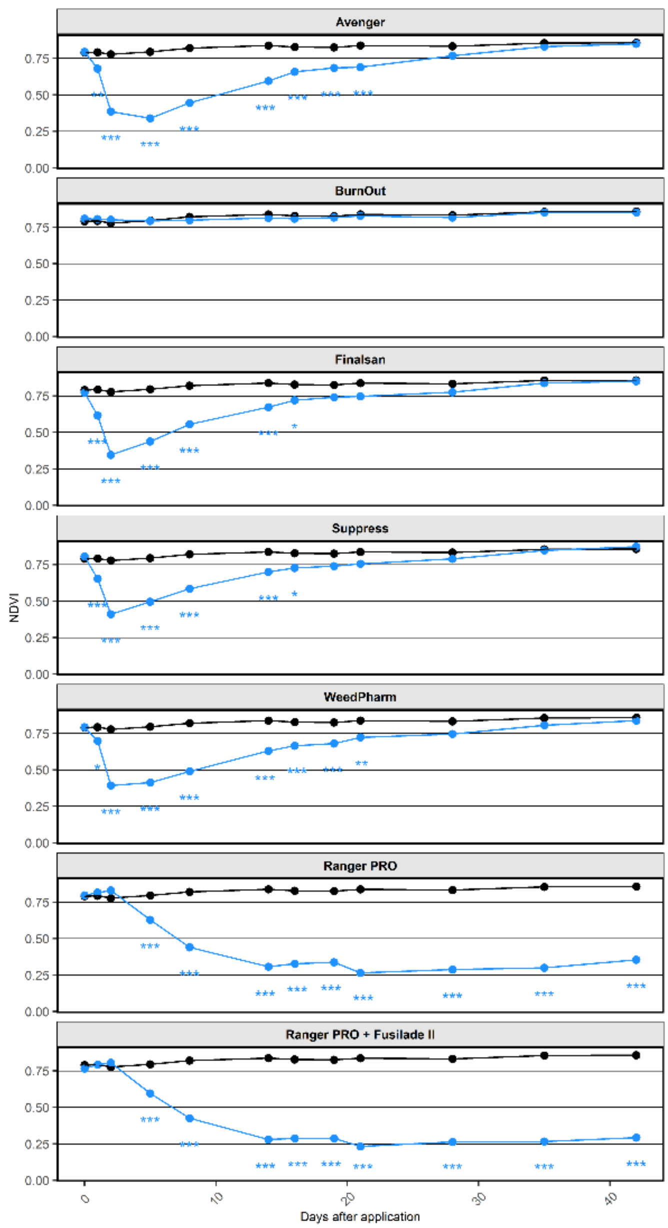

Figure 1. Bermudagrass injury expressed as normalized difference vegetation index (NDVI) for herbicide treatments (blue) compared to untreated control (black). * = p < 0.05, ** = p < 0.01, and *** = p < 0.001 according to Dunnett's test.

NativeKlean™ Herbicide (Aminopyralid+2,4-D): A New Herbicide for Native Grass Roughs on Golf Courses. Gilbert del Rosario, Corteva Agriscience. gilbert.del-rosario@corteva.com

Establishing native grass roughs (including naturalized grasses) in golf is an increasing trend. Superintendents seek every edge that enables them to reduce their required inputs and to optimize their current and often shrinking budgets. In fact, a recent USGA survey found that 46% of courses are increasing the area that is considered native and naturalized[1]. This enables superintendents to reallocate inputs of labor and machinery to other more prominent areas of a golf course.

Although native roughs may reduce maintenance, it does not eliminate it. Mowing is important to maintain the health of grasses, course playability, and for the ability of the player to find their ball. In addition, weed control is important for not only the course aesthetic but for the long-term function of the native rough. If the area is not already infested with invasive or weeds common to disturbed areas, the vegetation composition will attempt to return to its natural plant community.

Herbicides are an important tool in the establishment and maintenance of these native roughs. A recent blind survey found that combination herbicide products are the most common broadleaf herbicides used to maintain native grass roughs[2]. These products often contain 2,4-D ester, MCPP, dicamba and a variation of clopyralid, fluroxypyr or carfentrazone in a premix combination. Many of these combination products are designed for maintaining turfgrass on a golf course or residential property. Which means that many may or may not have an adequate active ingredient (a.i.) load to eliminate tough-to-control broadleaves and woody species often found in more mature stages in native grass roughs.

Lastly, most of the common products in the survey provide no or very little residual control of emerging weeds shortly after application. So often, a more costly preemerge broadleaf product must be tank mixed to achieve lasting control.

In response to the growing trend of this area on golf courses and the associated weed control challenges, Corteva Agriscience has developed NativeKlean™ herbicide especially for native and naturalized areas to provide a low maintenance solution for consistent control of broadleaf weeds.

NativeKlean™ herbicide is a makeup of 8.24% aminopyralid at 0.41lg/gal a.e. and 41% 2,4-D amine by weight or 3.33lb/gal a.e. Both aminopyralid and 2,4-D amine are classified as Group 4 herbicides. It has a danger signal word attributed to the amine formulation of 2,4-D.

The labeled rate is 19-34 fluid ounces though the recommended rate is 32 fluid ounces per acre. The 32 oz. rate is just short of the 34-ounce maximum use rate in 1 year. It is labeled for both broadcast and spot treatments. NativeKlean is packaged in a 1-gallon jug, enough to control 4 acres per container.

NativeKlean™ herbicide provides broadspectrum control of more than 100 broadleaf weeds. Because the resources and attention dedicated to these areas are intentionally fewer, invasive weeds and/or noxious weeds often establish. NativeKlean is effective in controlling many of these including hard to control high anxiety weeds such as thistle, marestail, fleabane, ragweed, clovers, cocklebur, dandelions, dogfennel, fireweed and problematic and prolific woody species such blackberry species and honey locusts.

Unlike many preemerge products that must watered in within short timeframes, aminopyralid is photo stable on the soil surface. Though it needs water to move the active to the germinating seedling under the soil surface, there is no watering-in restriction. NativeKlean is rainfast within 2 hours and has limited mobility in the soil making it is usable on sloped areas.

Product use throughout the country and small plot demonstrations throughout California have demonstrated residual control of key broadleaf weeds at least 3-months and in some trials demonstrated significantly longer control depending on weed type, pressure, and climatic conditions.

NativeKlean has been tested at 2x the labeled rate on more than 20 different grasses over 5 years. It has been found to provide a wide range of warm and cool season safety/tolerance common in native and naturalized areas throughout the country. Some species found tolerant of NativeKlean include bluestem (Andropogon spp), grama (Bouteloua spp.), buffalograss (Buchloe dactyloides), bermudagrasses (Cynodon spp), Festuca spp. (fescue), Lolium spp (ryegrass), Dactylis glomerate (orchardgrass), and Poa spp. (bluegrass).

It is important to adhere to use restrictions to ensure product stewardship. There is a 250' buffer zone from residential properties to minimize the off-target potential of physical 2,4-D amine drift.

NativeKlean is labeled up to the water's edge but is not to be applied at a distance from a tree equal to its height.

NativeKlean offers golf courses a new weed control tool for native and naturalized areas, providing a low maintenance solution for consistent control of broadleaf weeds.

References:

1. http://www.usga.org/content/usga/home-page/articles/2018/06/naturalized-areas-fescue-grasses-benefit-golf-courses.html
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Field Bindweed (*Convovulvis Arvensis*) Control in Cotton. Lynn Sosnoskie, Cornell University, Geneva, New York

Field bindweed is a deep-rooted perennial that has been a problem in California crop production since the 19th century. The persistence of field bindweed in the Central Valley is likely facilitated by and increasing transition to reduced tillage in many commodities. While soil-applied herbicides are not expected to be effective against perennial vines, some active ingredients in groups 2, 3 and 14 have shown some suppressive activity. The purpose of this study was to investigate the use of trifluralin (pre-plant incorporated) combined with glyphosate applications and cultivation in cotton to prevent early season competition with the crop. The study was conducted at the Westside Research and Extension Center in Five Points, CA, in 2019; soil at the site is a Panoche clay loam (15 to 26% clay, 35 to 60% sand, 0.2 to 0,7% OM, pH 7.8 to 8.0). The field that was selected for use in the trial was significantly infested with field bindweed (>70% cover); the site was disked twice prior to herbicide applications and planting to break up bindweed rhizomes and distribute the fragments evenly. Pima cotton was planted on 25 May 2019 due to late rains and emerged on 1 June. The study was a factorial design. Treatments included a residual herbicide application (1-none or 2-trifluralin applied pre-plant incorporated as Treflan at 24 oz/A) and a single post-emergence treatment (1-none, 2-glyphosate applied a Roundup Powermax at 32 oz/A, 3-Roundup Powermax applied at 32 oz/A followed by (fb) cultivation, or 4-cultivation only). Trifluralin was applied on 24 May 2019 at 30 GPA; glyphosate was applied on 27 June 2019 at 15 GPA; cultivation occurred on 8 July 2019. All treatment combinations were replicated four times. Individual plots were four 30-inch rows wide by 50 feet in length. Weed cover (% area covered in vines) data was collected weekly to every 10 days until 6 August 2019. Percent crop suppression and crop height data was recorded on 6 August.

Table 1. Field bindweed cover in Pima cotton in response to herbicides and cultivation

		Percent (%) bindweed cover									% Crop suppression	Crop height (ft)
PPI	POST	1-Jun	6-Jun	11-Jun	20-Jun	27-Jun	8-Jul	16-Jul	22-Jul	6-Aug	6-Aug	6-Aug
UTC	UTC	3.5	7.3	13.0	23.8	33.8	53.8	56.3	68.8	75.0	29.0	2.0
UTC	Glyphosate	3.0	12.5	20.0	30.0	51.3	56.3	52.5	55.0	53.8	31.0	1.8
UTC	Cultivation	1.3	6.8	15.5	27.5	42.5	71.3	6.3	10.0	51.3	35.0	1.9
UTC	Glyphosate FB Cultivation	2.8	6.5	13.0	27.5	42.5	42.5	1.0	0.5	6.5	16.0	2.5
Treflan	UTC	0.3	3.0	8.3	14.3	23.8	36.3	51.3	60.0	58.8	23.0	1.9
Treflan	Glyphosate	0.3	2.5	6.0	12.5	15.0	13.8	10.0	17.5	20.0	10.0	2.6
Treflan	Cultivation	1.0	5.0	7.0	18.8	31.3	43.8	3.5	7.8	20.0	24.0	2.3
Treflan	Glyphosate FB Cultivation	0.5	2.5	3.0	8.0	16.3	16.3	0.5	1.0	4.5	1.0	3.0

Field bindweed cover was generally higher where trifluralin was not applied (Table 1). Between 1 June 2019 and 27 June 2019, cover in the plots that did not receive trifluralin applications ranged from 1.3% to 51.3%; cover in the trifluralin plots ranged from 0.3% to 31.3%. Glyphosate and cultivation used alone were effective at suppressing field bindweed, but mostly when used in a system where trifluralin was applied pre-plant. The best treatment for suppressing field bindweed over time was a pre-plant application of trifluralin fb glyphosate fb cultivation (0.5 to 16.3% cover). Percent crop suppression (1%) was lowest and plant height was greatest (3.0 ft) in the trifluralin fb glyphosate fb cultivation plots on 6 August 2019.

Is the use of trifluralin PPI logical in cotton? This may depend on the level of infestation (very large) and type of cotton (absence of a roundup ready trait). Results suggest that the active ingredient can help to suppress perennial vine development when cotton is emerging and not competitive with weeds. Post emergence weed control in cotton is also crucial. Multiple treatments will be necessary; our results show that glyphosate fb cultivation improved suppression over either treat used singly. Growers should make sure to use manage field bindweed to the best of their abilities in preceding crops (via physical disturbance, herbicides, crop shading) as well as in fallow years.

Roundup Ready Alfalfa Injury. Tom Getts[1], Rob Wilson[2], Giuliano Galdi[3], Chet Loveland[4], Deborah Samac[5] and Earl Creech[6]

Since the second release in 2011, the Roundup Ready (RR) alfalfa technology has given growers an excellent tool, allowing control of difficult weeds while increasing the flexibility of herbicide application timing. Initial screening of the technology provided excellent crop safety at all application timings. In 2014, there was an initial observation of injury to Roundup Ready alfalfa after glyphosate application was followed by frost. Symptomology observed included necrosis of individual stems, as well as stunting of the crop. Replicated field trials in 2015, 2016 and 2017 confirmed these same symptoms regularly occur when glyphosate is applied to RR alfalfa followed by frost in Northern California. The field trials also documented first cutting yield was reduced up to 0.8 ton/acre compared to the untreated control at multiple sites. Yield reduction was greatest when glyphosate was applied to alfalfa between 8 and 10 inches tall, while yield reduction was minimized when the crop was treated before it grew four inches tall after dormancy. Lower rates of glyphosate (0.77 lb a.e./acre) generally caused less injury and yield loss compared to higher rates tested (1.54 lb a.e./acre). In 2019, a multi-state researcher team evaluated this phenomenon at multiple locations in California and Utah to better determine which management practices minimize crop injury from glyphosate. Another objective was to investigate a hypothesis that the crop injury is caused by *Pseudomonas syringae* (bacterial stem blight).

Update on Cover Crop Systems: Weed Management and Beyond. Anil Shrestha[1], Lynn Sosnoskie[2], and Jeff Mitchell[3]
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A cover crop is defined as a crop primarily grown to cover the soil and protect against erosion and nutrient losses. It is primarily grown between periods of regular crop production in annual cropping systems or between trees and vines in orchards and vineyards. The concept is not new as literature review suggests the use of cover crops over the millennia. Cover crops became more common in North America in the early 20th century but their use declined after the second World War due to the introduction of synthetic fertilizers (Groff, 2015). However, in recent years, there is renewed interest in cover crops due to soil health and quality concerns. Cover crops have the potential to reduce erosion, add organic matter, increase water infiltration, decrease nutrient loss, attract beneficial insects, suppress nematodes and weeds, increase soil microbial populations, and add nitrogen to the soil, if they are legumes (SARE, 2012a). Although, there are some potential challenges with cover crops which include depletion of soil moisture and nutrients, increased frost hazard, reduced soil temperatures in spring, increased pests, increased management costs, potential need for additional farm equipment, and termination (SARE, 2012b).

Generally, cover crops are terminated by use of broad-spectrum herbicides such as glyphosate, paraquat etc., mowing, or plowed down as green manures. However, in recent years there is a growing interest in termination of cover crops with roller-crimpers (e.g. Kornecki et al., 2009). Although roller-crimper technology has been explored quite a fair bit in several states in the US, the technology has not been tested adequately in California. A study was conducted in 2006 in California, but the technology was unsuccessful primarily due to regrowth of the cover crop in a no-till system (Luna et al., 2012). Because of the success of the technology in other parts of the US, the technology was revisited from 2018 in California in various annual cropping systems including vegetables and silage corn. One such study was the use of rolled crops in strip tillage silage corn system.

A study was initiated in Fall 2018 at California State University, Fresno. Cover crop treatments included high diversity mixtures, Merced rye + purple vetch + bell bean, Phacelia + rape, bell bean + Magnus pea, and Multiplex cover crop mixture (mixture of various small grains and legumes). The cover crops were seeded on December 14, 2018. Half an inch of water was applied with a center pivot overhead irrigation system after planting the cover crop after seeding. No further irrigation or any fertilizers were applied. The treatments were replicated four times in a randomized complete block design. Each plot was 15 ft wide and 145 ft long. The cover crops were terminated on April 23, 2019 by making two passes with a 15 ft wide roller crimper. Aboveground cover crop biomass prior to termination was estimated by taking two 0.5 m^2 quadrat samples in each treatment plot. A Roundup Ready silage corn variety was strip-till planted in all the plots on May 9, 2019. Visual estimates on percent cover crop residue, percent cover crop kill, and percent weed cover was made till late June. The corn was harvested in August, but no data was taken on crop yield.

The amount of cover crop residue prior to rolling ranged from 8 to 16 tons/ac with the greatest amount being in the high diversity mix while the other treatments had similar amounts. The amount of cover crop residue remaining on the soil surface varied between treatments. The greatest amount (about 90%) of residue was observed in the Merced rye + purple vetch treatment and the least (approximately 10%) in the bell bean + Magnus pea treatment. In the other treatments, residue in late June ranged from 55 to 85%. The percent cover crop kill by late June was 100% in all treatments except the plots with rape. The rape plants kept growing and competing with the corn crop, the percent kill was only 70%. The cover crop kill was primarily by the roller as herbicides were applied later in the season after the June evaluation. Percent weed cover in June was the least (approximately 2%) in the Merced rye + purple vetch + bell bean plots and the greatest (approximately 25%) in the Multiplex mixture plots. In the other treatments, it was generally less than 20%. The Phacelia + rape treatment had less than 5% weed cover. As mentioned earlier, corn yield was not recorded in the study. However, visual estimates suggested that silage corn yield was similar in all the plots except in the treatment with rape. The rape plants continued to compete with the corn crop till harvest and reduced yields by approximately 25% on a wet weight basis.

Therefore, this study showed that most of the cover crops used in the study, except rape, provided very good amount of biomass, was terminated successfully by the roller-crimper, provided excellent soil cover till the end of the corn growing season, and provided good weed suppression. Silage corn was successfully strip-till planted and established in all the treatment plots and crop yield was similar in all the plots except in those with rape. The roller-crimper technology could be a successful tool in annual cropping systems in California.

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Developing Chemical Control Strategies for Oblong Spurge (*Euphorbia oblongata*). Scott Oneto, UCCE Central Sierra; 12200B Airport Rd. Jackson CA 95642, sroneto@ucanr.edu

Oblong spurge is a native of Turkey and Southeast Europe and was introduced into California as an ornamental. It has since escaped and is expanding its range forming dense stands and outcompeting native and desirable plants along riparian areas, roadsides, disturbed areas, grasslands, coastal dunes and oak woodlands. Oblong spurge is an erect perennial to nearly 3 feet high with milky white sap and smooth, oblong leaves. The milky sap of spurges is toxic and can irritate the skin, eyes and digestive tracts of humans and other animals. Cattle tend to avoid foraging spurge, but goats and sheep appear more tolerant to its irritant properties. Flowers consisting of yellow bracts are produced in clusters at branch tips from April – September. Plants reproduce vegetatively from root crowns or via seed that are ejected up to 16 feet when ripe. In summer 2015, an herbicide trial was established in Pioneer, Amador County, California, to test several herbicides at different rates and application techniques. The herbicides and rates tested were glyphosate (Roundup Pro®) at 0.75, 1.5 and 1.2 a.e./acre, imazapyr (Chopper®) at 0.5, 1.0 and 0.8 lbs. a.e./acre, triclopyr ester (Garlon 4 Ultra®) at 2, 4 and 1.6lbs. a.e./acre, fluroxypyr ester (Vista XRT®) at 0.26 and 0.5 lbs. a.e./acre, aminopyralid / triclopyr (Capstone®)at 0.05/0.5, 0.1/1.0 and 0.04/0.4 lbs. a.e./acre, chlorsulfuron / aminopyralid / triclopyr (Telar XP®/Capstone®) at 0.04lbs. a.i./acre/0.05/0.5 lbs. a.e./acre, sulfometuron methyl/chlorsulfuron (Landmark®) at 0.06/0.03 and 0.13/0.06 lbs. a.i./acre and aminocyclopyrachlor/chlorsulfuron (Perspective®)at 0.1/0.04 and 0.2/0.08 lbs. a.i./acre. Applications were made using a CO2 backpack sprayer at 30 PSI and were applied either as a broadcast spray using a ten-foot boom with four XR8002 nozzles at 20 GPA or as a drizzle application using a spray gun fitted with a 0.02" orifice disk at 1.6 GPA. Each plot measured 10 ft. x 20 ft. and each treatment was replicated 4 times in a randomized block design. Results indicate that imazapyr at 0.8 lbs. a.e./acre applied as a drizzle technique provided 100% control one-year after application. Imazapyr applied at 0.5 and 1.0 lbs. a.e./acre using the broadcast method also provided excellent control, 93% and 88% respectively. Triclopyr ester and glyphosate each provided 70% control and showed increased efficacy when treated using the drizzle technique at 1.6 and 1.2 lbs. a.e./acre over the broadcast treatment. Broadcast applications of sulfometuron methyl / chlorsulfuron, aminocyclopyrachlor / chlorsulfuron and aminopyralid / triclopyr provided poor control. These results provide several chemical control options for oblong spurge and give land mangers flexibility with herbicide and application technique in their management programs.

Using Rx Fire to Control Invasive Weeds: Fire Behavior and Planning Considerations. Jonathan Pangburn, CAL FIRE, San Benito-Monterey Unit, Jonathan.Pangburn@fire.ca.gov

In California, land managers must consider the ecosystem, potential effects, objectives, available partners, and costs of weed management tools including prescribed fire. Historic, current, and desired future fire regimes will impact the decision to use or not use fire as a vegetation management tool. When considering prescribed fire as a fuel management tool, managers must keep in mind their purpose, what tools are available to them, the timing of treatment, and the safety precautions necessary for preparing a burn. Vegetation Management Program (VMP) burns with CAL FIRE or range improvement burns led by private landowners are the two key ways that prescribed fire can be applied to the landscape and can be used as alternatives to, or in combination with, mechanical treatments, hand treatments, prescribed grazing, and/or pesticides. Two example species which can be treated with prescribed fire in combination with other tools include brooms (*Genista* spp.) and yellow starthistle (*Centaurea solstitialis*). When burning to control invasive species, managers must take caution in decontaminating key equipment, monitoring the effects of the fire, and properly timing any secondary treatments. Regardless of the purpose, all prescribed burns need a well-defined burn plan and preparation to adjust the plan to ensure safe, successful treatment.

Using prescribed fire in combination with herbicide to control yellow star thistle (*Centaurea solstitialis*). Brent Johnson and Amelia Byrd Ryan, Pinnacles National Park

In 2006, Pinnacles National Park acquired a 2000 acre historic ranch with beautiful valley oak savannah. Unfortunately, these lands were also heavily infested with yellow star thistle (YST). In order to address this infestation, Pinnacles embarked on an ambitious YST control project. One hundred and twenty acres of the most heavily infested portion of the ranch were burned. Burn treatment was followed the next year with broadcast herbicide treatment of aminopyralid (Milestone(r)), a low-toxicity herbicide highly effective at targeting specific plant groups, particularly thistles. Broadcast herbicide was followed by spot treatment in year three. These treatments resulted in a precipitous decline in the YST cover to less than 1% that Pinnacles has maintained for 8 years using only hand treatment and occasional spot spraying. With YST successfully controlled, Pinnacles is embarking on the next phase of restoration of the savannah, and continuing to partner with others in the region interested in using similar techniques on YST.

Strategic Integration of Ruminant Herds into Plant-Based Ecosystems. Lee Hazeltine, Targeted Grazing Practitioner, Integrazers

Successful alfalfa production requires effective weed management. When alfalfa production occurs without use of chemical treatment options weed management strategies become more difficult. Grazing as a weed management tool has potential to support successful alfalfa production in the absence of chemicals. Since most non chemical alfalfa production strategies in the central Sacramento valley have had limited long term success a grazing trial during active hay production was conducted. Herds of sheep and goats were used to graze alfalfa very soon after the second and third hay cuttings were baled. Increased alfalfa tonnage per acre of a higher quality were achieved compared to non-grazed alfalfa. Non alfalfa plant biomass as a percentage of total harvested biomass was reduced in grazed vs. non-grazed alfalfa. Water soluble (bioavailable) soil nitrogen and phosphorus, as well as microbial community size trended higher in grazed vs. non grazed soils.

Autonomous Mechanical Weeder for Vegetable Production. Pauline Canteneur, FarmWise Labs, San Francisco, CA, USA. (pauline.canteneur@farmwise.io)

Today, the vegetable crop industry is under pressure. On the one hand, one of its two main resources, labor, is affected by profound regulatory and demographic trends, leading costs to skyrocket. On the other hand, vegetable growers are often left with few chemical weed control options.

Meanwhile promising technologies have demonstrated successful applications in various sectors of the economy. Artificial intelligence (AI) applied to computer vision is helping self-driving car companies like Waymo or Cruise Automation break ground and deliver on the promise of autonomous cars on the open road. These two technologies are also at the core of facial recognition leveraged by the retail and security industries among others. The development of practical applications to AI tied to computer vision has been encouraged by progress in hardware and software technologies in recent years (better adapted cloud infrastructure, GPUs allowing faster processing). In addition, robotics has already demonstrated great applications in healthcare and the automotive industry. According to the International Federation of Robotics, 55 percent of the total demand for industrial robots comes from the automotive sector alone. The democratization of open source platforms like ROS and the decreasing cost of hardware, thanks to quick prototyping through tools like 3D printers and laser cutters, have largely contributed to the emergence of commercial robotic products.

Today, AI and robotics can bring tremendous value to agriculture as well. . Thanks to computer vision and AI, it is now possible to teach a system how to distinguish between plant species. These technologies also offer the opportunity to count the number of plants on a given field, measure their size, locate their stem and even generate 3D models of these plants. As for robotics, we have reached a point where we are able to build platforms performing actions - opening and closing blades for instance - quickly and repetitively at a precise location. Self-propelled mechanical weeders like FarmWise's are reaching vegetable growers' fields. Aided by AI and computer vision, these machines are capable of performing inter and intra-row weeding at a favorable speed and competitive cost.

Evaluation of Sulfentrazone, Oxyfluorfen and *S*-Metolachlor in Brassica Vegetables.

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

Small acreage Brassica vegetables need additional herbicide options. Among the vegetables grown in California are a number of niche crops such as Bok choi and Brussels sprouts that have a limited number of registered herbicides such as DCPA (Dacthal, Anonymous 2019a). Sulfentrazone (Zeus) now has a food use tolerance for use on Brassica head and stem group 5-16, which includes crops such as Bok choi and Brussels sprouts as well as Brassica leafy greens subgroup 4-16B, which includes crops such as kale (USEPA 2017; USEPA 2018). However, there is a lack of data for Zeus on a wide variety of Brassica vegetables, and the objective of this work was to gather crop tolerance data for Zeus on a wide variety of Brassica vegetables.

During 2019 we evaluated Zeus at 0.07, 0.094 and 0.14 lbs. ai/A applied 72 hours before seeding or transplanting and S-metolachlor (Dual Magnum) at 0.33, 0.5 and 0.65 lbs. ai/A PRE, and oxyfluorfen at 0.25 and 0.5 lbs. ai/A POST on direct seeded Bok choi, broccoli raab, collards, mizuna, mustard greens and radish, as well as transplanted Brussels sprouts and kale. The standard was Dacthal PRE at 7.5 lbs. ai/A. The trials were conducted at Salinas, CA during May to November 2019. The Bok choi and broccoli raab trial ran May 3 to June 24; the collard and mizuna trial ran May 3 to June 26, and the radish and mustard greens trial ran June 20 to August 2. The Brussels sprouts and kale study was transplanted June 20, and the kale was harvested August 20. Brussels sprouts will be harvested likely in November. Treatments were replicated 4 times and arranged in a randomized complete block design. Data collected was crop injury estimates, stand and yield as well as weed control. Data were subjected to analysis of variance and mean separation was performed using LSD's.

Results.

Seeded crops. Dacthal and Dual Magnum caused little or no visible injury to Bok choi, broccoli raab, collards, and mizuna, radish or mustard greens (Table 1). Collards, radish and mustard greens were tolerant to Zeus at 0.07 and 0.094 lbs. ai/A but not at 0.14 lbs. ai/A. Bok choi, broccoli raab, and mizuna were injured by Zeus at all rates. GoalTender at 0.25 and 0.5 lbs. ai/A caused moderate to severe injury to all seeded crops (Table 2). None of the herbicides reduced yield in Collards (Table 3). Compared to Dacthal, yields in Dual Magnum treatments were similar. GoalTender reduced yields in mizuna, radish and mustard greens. GoalTender caused marginal yield reductions in Bok choi and broccoli raab.

Transplanted crops. Brussels sprouts and kale were established as transplants. Dacthal, Zeus and Dual Magnum were safe on Brussels sprouts and kale (Table 4). GoalTender was mostly safe on Brussels sprouts. GoalTender caused severe injury in kale. None of the herbicide treatments reduced kale yield. Brussels sprouts was not yet harvested at the time of this report.

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Table 1. Crop injury (0 =no injury, 10=dead) estimates in direct seeded crops

Treatment	**Rate**	**Timing**	Bok choi	Broccoli raab	Collards	Mizuna	Radish	Mustard greens
	Lbs ai/A		**Crop injury (0-10)**					
Nontreated	0	---	0.0 d	0.0 e	0.0 d	0.0 b	0.0 d	0.0 c
Dacthal	7.5	PRE	0.9 d	1.3 d	0.0 d	0.6 b	0.0 d	0.0 c
Zeus	0.07	PREPL	3.0 c	4.9 c	1.6 c	8.5 a	1.5 bc	0.3 c
Zeus	0.094	PREPL	4.5 b	6.9 b	2.3 b	9.3 a	2.0 ab	1.4 b
Zeus	0.14	PREPL	8.9 a	9.4 a	3.8 a	9.6 a	2.6 a	2.4 a
Dual Magnum	0.33	PRE	0.1 d	0.0 e	0.0 d	0.3 b	0.0 d	0.0 c
Dual Magnum	0.5	PRE	0.0 d	0.5 de	0.0 d	0.6 b	0.3 d	0.0 c
Dual Magnum	0.65	PRE	0.4 d	0.3 e	0.3 d	0.6 b	0.8 cd	0.3 c

Table 2. Initial crop injury (0 =no injury, 10=dead) estimates for POST applications on on direct seeded crops.

Treatment	**Rate**	**Timing**	Bok choi	Broccoli raab	Collards	Mizuna	Radish	Mustard greens
	Lbs ai/A		**Crop injury (0-10)**					
Nontreated	0	---	0.0 c	0.0 c	0.0 c	0.0 c	0.0 c	0.0 c
GoalTender	0.25	POST	3.5 b	5.6 b	2.4 b	5.8 b	5.3 a	7.8 b
GoalTender	0.5	POST	4.7 a	6.9 a	3.6 a	6.6 a	5.8 a	8.8 a

Table 3. Fresh weights in direct seeded crops

Treatment	Rate	Timing	Bok choi	Broccoli raab	Collards	Mizuna	Radish	Mustard greens
	Lbs ai/A		(tons/A)					
Nontreated	0	---	14.1 abc	0.95 a	7.3	4.6 ab	6.0 ab	7.90 a
Dacthal	7.5	PRE	15.0 a	0.73 bc	7.2	5.0 a	6.9 a	9.48 a
Zeus	0.07	PREPL	14.3 abc	0.52 cd	6.8	2.7 cd	5.9 ab	8.78 a
Zeus	0.094	PREPL	12.7 bcd	0.43 de	6.3	1.7 de	5.4 bc	8.83 a
Zeus	0.14	PREPL	11.1 d	0.30 e	6.3	0.7 e	4.3 c	8.88 a
GoalTender	0.25	POST	12.4 cd	0.66 bc	6.6	2.9 cd	2.3 d	3.91 b
GoalTender	0.5	POST	13.5 abc	0.52 cd	6.1	3.2 bcd	1.8 d	2.92 b
Dual Magnum	0.33	PRE	13.9 abc	0.82 ab	6.1	3.0 bcd	7.1 a	8.60 a
Dual Magnum	0.5	PRE	14.4 ab	0.78 ab	6.6	4.1 abc	7.1 a	8.93 a
Dual Magnum	0.65	PRE	14.8 a	0.68 bc	7.1	4.3 abc	7.1 a	9.50 a

Table 4. Injury estimates in transplanted Brussels sprouts and kale and fresh weights in kale. Brussels sprouts will be harvested November 2019.

Treatment	Rate	Timing	Brussels sprouts	Kale	Brussel sprouts	Kale	Kale
	Lbs ai/A		Crop injury (0-10)				Tons/A
Nontreated	0	---	0.0 c	0.0 b	0.0 c	0.0 c	8.4
Dacthal	7.5	PRE	0.0 c	0.0 b			8.6
Zeus	0.07	PREPL	0.0 c	0.5 ab			8.0
Zeus	0.094	PREPL	0.0 c	0.1 b			8.3
Zeus	0.14	PREPL	1.0 a	1.0 a			8.6
GoalTender	0.25	POST`	---	---	1.4 b	5.8 b	8.0
GoalTender	0.5	POST	---	---	2.5a	6.6 a	8.2
Dual Magnum	0.33	PRE	0.0 c	0.0 b			7.8
Dual Magnum	0.5	PRE	0.4 b	0.0 b			8.8
Dual Magnum	0.65	PRE	0.0 c	0.3 b			8.1

Promertyn in Cilantro Effects on Rotational Vegetables, and Safety and Efficacy of Drip-applied Pronamide in Lettuce. Oleg Daugovish, UCCE, Ventura County Farm Advisor.

Prometryn applied pre-emergence in cilantro at two rates provided excellent weed control of broadleaf weeds and did not injure cilantro at two coastal locations. After beds were reshaped four vegetable crops were established and evaluated. No significant injury was observed in transplanted peppers, Napa cabbage or Brussel sprouts at 60, 90 and 120 days after treatment (DAT), but direct seeded Napa cabbage and spinach had injury at 60 DAT at one location which was not visible at later evaluations and no yield losses occurred in these vegetable crops at either location. Additionally, there was no residual weed control in rotational vegetable following cilantro suggesting that prometryn is not present at herbicidal levels in soil and vegetable crops scan be produced safely following pre-emergence prometryn application in cilantro in coastal California. Pronamide applied via drip during the second irrigation in transplanted lettuce provided good control of broadleaf weeds that was not significantly different from spray application. Both applications were non-injurious to romaine lettuce and resulted in similar yields.

Protecting Specialty Crops from Pests – How the IR-4 Project Helps Meet Farmer Pest Control Needs. Authors/affiliation: Michael Horak, Mika Tolson, Stephen Flanagan, Western Region IR-4 Project, University of California, Davis. mjhorak@ucdavis.edu

Since 1963 the IR-4 Project has been the primary resource for facilitating registrations of conventional chemical pesticides and biopesticides for specialty crops and other minor uses in the United States. Using its unique ability to partner with government, industry and farmers, IR-4 develops required data to support registration of pest management products. IR-4 is funded through a grant from the US Department of Agriculture – National Institute of Food and Agriculture and through in-kind support from land grant universities. The California Department of Food and Agricultural also provides funding for projects of specific interest to California farmers. IR-4's aim is to provide safe and effective pest management solutions for specialty crop farmers. There are three component programs of the overall IR-4 Project including a) Food Use (residue, efficacy and crop safety); b) Integrated Solutions (organic support, resistance management, residue mitigation, and screening); and c) Environmental Horticulture (efficacy and crop safety). This presentation will focus on how you can participate in the processes of the IR-4 project to meet your stakeholder's pest management needs.

Glyphosate and Cancer: An Ongoing Controversy. David A. Eastmond, Environmental Toxicology Graduate Program, University of California, Riverside, CA, (david.eastmond@ucr.edu)

In 2015, a working group convened by the WHO's International Agency for Research on Cancer (IARC) conducted a hazard assessment focusing on the carcinogenicity of glyphosate. It concluded that glyphosate, historically considered to be a very safe pesticide, was a probable human carcinogen. This prompted the WHO through its Joint Meeting on Pesticide Residues (JMPR) to conduct a re-assessment of the risks of glyphosate as a pesticide residue, which led to the conclusion that glyphosate residues in the diet were unlikely to pose a cancer risk. The IARC evaluation also led to other U.S. and international regulatory agencies to re-evaluate the carcinogenicity of glyphosate. While almost all of these have concluded that glyphosate does not pose a significant cancer risk, concerns have more recently been raised by other groups about other potential adverse effects of this important agrochemical. In particular, concern has been raised about adverse effects that might occur in occupationally exposed workers such as pesticide applicators. More recently, as a result of the IARC evaluation, the California EPA's Office of Environmental Health Hazard Assessment added glyphosate to the list of chemicals known to the state as causing cancer. My presentation will briefly review the mutagenicity and carcinogenicity of glyphosate, compare the evaluations by the two WHO groups (IARC and JMPR), and discuss more recent information that has emerged on the risks and regulation of this widely used and important herbicide.

Responding to Pesticide Emergencies. Henry Gonzales, Monterey County Agricultural Commissioner

Presenter discussed how to respond when faced with a serious medical emergency like exposure in the workplace in compliance with California pesticide worker safety law. This presentation included the following major topic areas:

- Identify common symptoms of pesticide over exposure
- What to do when you witness someone who is incapacitated
  - Don appropriate PPE
  - Call an ambulance or provide rapid transport to an appropriate medical facility
  - Call CA poison control center
  - Give basic first aid until the person is in the care of a medical professional
- Know what information to provide to poison control and medical professionals
  - EPA registration number
  - product label
  - safety data sheet (SDS)
  - Avoid bringing the pesticide container into the ER unless sealed in a plastic bag to prevent exposure to medical personnel and others.
- If several fieldworkers are experiencing symptoms of possible exposure, then all employees need to be taken to the hospital right away.
- If the person arrives at the hospital contaminated with pesticide residues, they must remain in the vehicle until medical personnel can direct the person to a decontamination tent to flush the person free of residues before starting treatment.
- Know the different ways you can report a pesticide exposure incident:
- The CASPIR (California's System for Pesticide Incident Reporting) smartphone application
- Calling your local county agricultural commissioner's office
- Common issues seen by Monterey CAC, plus some tips
  - He often encounters people driving themselves to the hospital – a violation of pesticide worker safety law.
  - He encourages employers to prepare in advance of an incident by arranging with a company or grower in the area with a vehicle large-enough for transport of many individuals to the nearest emergency medical facility.
- Physicians are mandated to report exposure incidents, which results in an illness report to the California Department of Pesticide Regulation for statewide recordkeeping.

California Weed Science Society
Custom Summary Report
July 1, 2019 through June 11, 2020

	Jul 1, '19 - Jun 11, 20
Ordinary Income/Expense	
Income	
4000 · Registration Income	135,930.40
4001 · Membership Income	1,960.00
4020 · Exhibit Income	15,100.00
4030 · Sponsor Income	17,500.00
4040 · CWSS Textbook Income	1,233.38
4065 · Orchid Fundraiser	465.00
4290 · Refunds	-2,152.00
Total Income	170,036.78
Gross Profit	170,036.78
Expense	
4300 · Conference Accreditation	175.00
4320 · Conference Catering Expense	49,136.29
4330 · Conference Equipment Expense	3,325.00
4360 · Student Awards/Poster Expense	2,100.00
4361 · Awards-Board/Special Recog.	214.00
4370 · Scholarship Expense	9,500.00
4380 · Conference Supplies	773.83
6090 · Advertising	1,719.94
6105 · Merchant Services Fees	6,669.81
6130 · Board Meeting Expenses	1,393.22
6135 · President's Reception	484.60
6240 · Insurance - General	3,349.00
6270 · Legal & Accounting	920.00
6280 · Mail Box Rental Expense	106.00
6300 · Office Expense	160.04
6307 · Outside Services - PAPA	49,094.65
6340 · Postage/Shipping Expense	72.76
6345 · Printing Expense	81.13
6355 · Website Expense	2,270.00
6440 · Office Supplies Expense	238.28
6500 · Taxes - Other	990.00
6530 · Travel - Transport/Lodging	2,248.89
6540 · Travel - Meals/Entertainment	116.84
6545 · Student Travel - Transport/Lodg	1,457.00
6555 · Speaker Lodging/Travel Expense	3,694.54
Total Expense	140,290.82
Net Ordinary Income	29,745.96
Net Income	**29,745.96**

Wells Fargo Checking Balance 6/11/20 - $69,616.28

Edward jones Investment Account 5/31/20 - $369,259.74

Harry Agamalian (1983) Norman Akesson (1998) Floyd Ashton (1990) Alvin Baber (1995) Walter Ball * Dave Bayer (1986) Carl E. Bell (2010) Lester Berry Tim Butler (2008) Mick Canevari (2008) Don Colbert (2002) Floyd Colbert (1987) Stephen Colbert (2012) Alden Crafts * Marcus Cravens * Dave Cudney (1998) Richard Dana * Boysie Day * Nate Dechoretz (2003) Jim Dewlen (1979)* Paul Dresher * Ken Dunster (1993)* Matt Elhardt (2005) Clyde Elmore (1994) Bill Fischer * Steven Fennimore (2019) Dick Fosse * Tad Gantenbein (2004) Rick Geddes (2006) George Gowgani Bill Harvey * David Haskell (2009) Kurt Hembree (2020) F. Dan Hess (2001)* Floyd Holmes (1979) Nelroy Jackson (1997)* Scott A. Johnson (2013) Warren Johnson (1977)* Harold Kempen (1988) Bruce Kidd (2009) Don Koehler (2003)	Jim Koehler Butch Kreps (1987) Edward Kurtz (1992) Art Lange (1986) Wayne T. Lanini (2011) Michelle Le Strange (2015) J. Robert C. Leavitt (2010) Oliver Leonard * Judy Letterman (2017) Jim McHenry * Bob Meeks Bob Mullen (1996) Robert Norris (2002) Ralph Offutt Steve Orloff (2017)* Jack Orr (1999) Ruben Pahl (1990) Martin Pruett Murray Pryor * Richard Raynor Howard Rhoads * Jesse Richardson (2000) John Roncoroni (2018) Ed Rose (1991)* Conrad Schilling * Jack Schlesselman (1999) Vince Schweers (2003) Deb Shatley (2009) Conrad Skimina (2003) * Richard Smith (2020) Leslie Sonder * Stan Strew* Huey Sykes (1989) Tom Thomson (1999) Robert Underhill Lee VanDeren (1983) * Ron Vargas (2001) Stan Walton (1988) * Bryant Washburn (1988) Steve Wright (2007) *Deceased

CWSS AWARD OF EXCELLENCE MEMBERS LISTING

1985 June McCaskell, Jack Schlesselman & Tom Yutani
1986 Harry Agamalian, Floyd Colbert & Ed Rose
1987 Bruce Ames, Pam Jones, & Steve Orloff
1988 Bill Clark & Linda Romander
1989 Earl Suber
1990 Ron Hanson & Phil Larson
1991 John Arvik & Elin Miller
1992 Don Colbert & Ron Kelley
1993 Ron Vargas
1994 Jim Cook & Robert Norris
1995 Mick Canevari & Rich Waegner
1996 Galen Hiett & Bill Tidwell
1997 David Haskell & Louis Hearn
1998 Jim Helmer & Jim Hill
1999 Joe DiTomaso
2000 Kurt Hembree
2001 Steven Fennimore, Wanda Graves & Scott Steinmaus
2002 Carl Bell & Harry Kline
2003 Dave Cudney & Clyde Elmore*
2004 Michelle LeStrange & Mark Mahady
2005 Scott Johnson & Richard Smith
2006 Bruce Kidd, Judy Letterman & Celeste Elliott
2007 Barry Tickes & Cheryl Wilen
2008 Dan Bryant & Will Crites
2008 Ken Dunster* & Ron Vargas*
2009 Ellen Dean & Wayne T. Lanini
2010 Lars W.J. Anderson & Stephen F. Colbert
2011 Jennifer Malcolm & Hugo Ramirez
2012 Rob Wilson
2013 Rick Miller
2014 Carl Bell*, Brad Hanson & Anil Shrestha
2015 Deb Shatley & Barry Tickes
2016 Steven Fennimore
2017 Steven D. Wright*
2018 Kassim Al-Khatib & Scott Stoddard
2019 Josie Hugie & Scott Oneto
2020 Ben Duesterhaus & Lynn Sosnoskie

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

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CWSS 2020 ANNUAL CONFERENCE – AUTHOR INDEX

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

CALIFORNIA WEED SCIENCE SOCIETY
Conference History

CONFERENCE	DATES HELD	LOCATION	PRESIDENT
43rd	January 21, 22, 23, 1991	Santa Barbara	Jack Orr
44th	January 20, 21, 22, 1992	Sacramento	Nate Dechoretz
45th	January 18, 19, 20, 1993	Costa Mesa	Alvin A. Baber
46th	January 17, 18, 19, 1994	San Jose	James Greil
47th	January 16, 17, 19, 1995	Santa Barbara	Nelroy Jackson
48th	January 22, 23, 24, 1996	Sacramento	Dave Cudney
49th	January 20, 21, 22, 1997	Santa Barbara	Jesse Richardson
50th	January 12, 13, 14, 1998	Monterey	Ron Vargas
51st	January 11, 12, 13, 1999	Anaheim	Scott Johnson
52nd	January 10, 11, 12, 2000	Sacramento	Steve Wright
53rd	January 8, 9, 10, 2001	Monterey	Matt Ehlhardt
54th	January 14, 15, 16, 2002	San Jose	Lars Anderson
55th	January 20, 21, 22, 2003	Santa Barbara	Bruce Kidd
56th	January 12, 13, 14, 2004	Sacramento	Pam Geisel
57th	January 10, 11, 12, 2005	Monterey	Debra Keenan
58th	January 16, 17, 18 2006	Ventura	L. Robert Leavitt
59th	January 8, 9, 10, 2007	San Diego	Deb Shatley
60th	January 28, 29, 30, 2008	Monterey	Carl Bell
61st	January 28, 29, 30, 2009	Sacramento	Stephen Colbert
62nd	January 11. 12. 13 2010	Visalia	Stephen Colbert
63rd	January 19, 20, 21, 2011	Monterey	Dave Cheetham
64th	January 23, 24, 25 2012	Santa Barbara	Michelle Le Strange
65th	January 23, 24, 25 2013	Sacramento	Chuck Synold
66th	January 22, 23, 24 2014	Monterey	Steve Fennimore
67th	January 21, 22, 23, 2015	Santa Barbara	Rick Miller
68th	January 13, 14, 15, 2016	Sacramento	John Roncoroni
69th	January 18, 19, 20, 2017	Monterey	Katherine Walker
70th	January 24, 25, 26, 2018	Santa Barbara	Maryam Khosravifard
71st	January 23, 24, 25, 2019	Sacramento	Joseph Vassios
72nd	January 22, 23, 24, 2020	Santa Barbara	Brad Hanson