California Plant and Soil Conference

Tuesday-Thursday, February 1-3, 2022

Solutions in a Time of Scarcity – California's Water Future

Book of Abstracts

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Virtual Event via Zoom

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

American Society of Agronomy
California Chapter

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California Chapter – American Society of Agronomy

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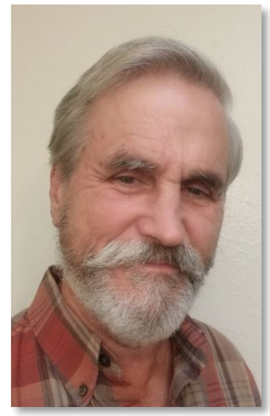
California Chapter Honorees

YEAR	HONOREE	YEAR	HONOREE	YEAR	HONOREE
1973	J. Earl Coke	1997	Jolly Batcheller	2011	Blaine Hanson
1974	W.B. Camp		Hubert B. Cooper, Jr.		Gene Maas
1975	Ichiro “Ike” Kawaguchi		Joseph Smith		Michael Singer
1976	Malcom H. McVickar	1998	Bill Isom	2012	Bob Matchett
	Perry R. Stout		George Johannessen		Don May
1977	Henry A. Jones	1999	Bill Fisher		Terry Prichard
1978	Warren E. Schoonover		Bob Ball	2013	Harry Cline
1979	R. Earl Storie		Owen Rice		Clyde Irion
1980	Bertil A. Krantz	2000	Don Grimes		Charles Krauter
1981	R.L. “Lucky” Luckhardt		Claude Phene	2014	Gene Aksland
1982	R. Merton Love		A.E. “Al” Ludwick		Kerry Arroues
1983	Paul F. Knowles	2001	Cal Qualset		Stuart Pettygrove
	Iver Johnson		James R. Rhoades	2015	Bob Beede
1984	Hans Jenny	2002	Emmanuel Epstein		Carol Frate
	George R. Hawkes		Vince Petrucci		Allan Romander
1985	Albert Ulrich		Ken Tanji	2016	Larry Schwankl
1986	Robert M. Hagan	2003	Vashek Cervinka		Scott Johnson
1987	Oscar A. Lorenz		Richard Rominger		Joe Fabry
1988	Duane S. Mikkelsen		W.A. Williams	2017	Ronald J. Brase
1989	Donald Smith	2004	Harry Agamalian		Kenneth G.Cassman
	F. Jack Hills		Jim Brownell		William L. Peacock
1990	Parker F. Pratt		Fred Starrh		Oliberio Cantu
1991	Francis E. Broadbent	2005	Wayne Biehler	2018	Jose I. Faria
	Robert D. Whiting		Mike Reisenauer		Peter B. Goodell
	Eduardo Apodaca		Charles Schaller		Timothy K. Hartz
1992	Robert S. Ayers	2006	John Letey, Jr.	2019	James E. Ayars
	Richard M. Thorup		Joseph B. Summers		Mary L. Bianchi
1993	Howard L. Carnahan	2007	Norman McGillivray		Gene Miyao
	Tom W. Embelton		William Pruitt	2020	Louise Jackson
	John Merriam		J.D. Oster		Steve Orloff
1994	George V. Ferry	2008	V.T. Walhood		Steven D. Wright
	John H. Turner		Vern Marble	2021	Keith Backman
	James T. Thorup		Catherine M. Grieve		Marsha L. Campbell
1995	Leslie K. Stromberg	2009	Dennis Westcot	2022	Blake Sanden
	Jack Stone		Roland Meyer		Bruce Roberts
1996	Henry Voss		Nat Dellavalle		
	Audy Bell	2010	L. Peter Christensen		
			D. William Rains		

2022 Honorees

Blake Sanden

Presented by Bob Beede



It is a sincere honor to be the presenter for Blake Sanden, one of this year's American Society of Agronomy, California Chapter, Honoree's. I have known Blake since we were undergraduates at UC Davis. Blake earned his Bachelor of Science degree in International Agricultural Development and Agronomy in 1978. Recently married to the striking young lady, Sue McCullough, also a recent UC Davis B.S. graduate in Genetics, the couple put their new skills to work as missionaries in Zambia for five years developing literacy programs, assisting village medical clinics, and improving field and vegetable crops production practices. Upon their return to the States, Blake worked as the farm manager for Woodlake High School before returning to Davis for a master's degree in Water Science, Irrigation and Drainage in 1985. I was reunited with Blake when he became the Irrigation Technical Advisor for Paramount Farming Company, Westside Ranch; near Lost Hills in February of 1988.

He was responsible for irrigation scheduling and system maintenance on 26,000 acres of pistachios, almonds, olives, grain, and cotton. After several attempts, I had finally landed a UC farm advisor position in neighboring Kings County in 1979, and had been heavily involved with learning about and researching pistachios with Leland McCarthy's resident Entomologist, Gary Weinberger. Blake had a very arduous position complicated by an immediate supervisor who could be as ornery as a WWII drill sergeant. However, to Blake's great credit, he did not complain; I mention this as a reflection upon Blake's strong and understanding character. After four and a half years of boot camp, Blake applied successfully for the UC Extension Soils, Water, and Agronomy Farm Advisor position in Kern County. After all he had already accomplished, Blake was just getting warmed up when Hodge Black, the County Director, introduced him to the staff in July of 1992.

Those of you familiar with California agriculture recognize that Kern County could be a state unto itself when it comes to oil and agribusiness. It is a mecca for big farms, big ideas, and big expectations for innovation. George Ferry, the Kern County Soils and Water Advisor in the 50's and 60's, who became my Director in Kings County, used to say, "You can grow anything in any quantity from apples to zucchini in Kern County." Water allocation and management typifies the collective ability of Kern growers to accomplish big goals; although lowest in average rainfall in the entire Central Valley due to its most southern location, Kern County has one of the most sophisticated regional irrigation systems in the state to move surface water directly to farms and to more than 20 groundwater banking projects around the county. This water is sourced from the local Kern River, Friant Federal Bureau of Reclamation water from southwest Sierra Nevada snowpack, and the California Aqueduct State Water Project on the Westside bringing northern California-Delta water south. These agricultural visionaries also saw the wisdom in partnering with the University of California Extension system to facilitate achievement of their goals. In keeping with the high academic standards exemplified by other advisors in the Kern office, Blake most definitely did not disappoint them in his dedication to performing outstanding research and education outreach to the local, statewide, and international farming communities. Blake was the backbone of the UCCE soils and water program in the Southern San Joaquin Valley.

In support of my above claims, I wish to now outline some of Blake's key accomplishments during the last 13 years of his UC tenure; in total, Blake was Principal Investigator on 18 projects, Co-PI on 9 and a cooperator on 5.

1. Irrigation water use efficiency (WUE), soil moisture monitoring: Continuously recording soil moisture sensors linked to an in-field data logger were installed in 145 fields covering more than 12,000 acres belonging to 33 different growers in 14 different crops by Blake and his staff from 2002-2013. The average measured water use efficiency for all study fields in which neutron probe monitoring was done was estimated at 95%. This large-scale data is cited by the Department of Water Resources and one of the largest civil engineering contractors in the San Joaquin Valley in the policy development for the Irrigated Lands Regulatory Program.
2. Almond water use and yield: Blake monitored the applied water in 34 almond blocks (3,583 acres) with greater than 70% canopy from 2002-2005. Average water use was 46.8 inches with a WUE of 96%. A reduced number of blocks monitored from 2006-7 averaged 50.2 inches. This water use is about 15% greater than the 42 inches UC published 40 years ago. Thus, modern soil moisture monitoring technology revealed that southern SJV almonds required more water for optimal growth and yield. This greater water requirement was confirmed by an intensive five-year statewide water production function trial from which imposed irrigation levels from 70 to 110% of ET. The new ETc increased the average Kern County almond yield by 65% between 2002 and 2011 compared to the previous15 years.
3. Refining Pistachio Crop Coefficients: Growers employing stem water potential and soil moisture monitoring report application of less total water than dictated by the original Kc values derived from the water balance method. Using aerial imagery, soil moisture monitoring, applied water data, and meteorological energy balance field data, Blake verified that much of the pistachio acreage in the southern San Joaquin Valley uses less water than the UC coefficients (Kc) determined 20 years ago would suggest. This has improved water use efficiency in his region.
4. Refining Alfalfa and Citrus Crop Coefficients: Deficit irrigation trials conducted by Blake indicate higher water use crop coefficients for these crops than values previously published for the southern San Joaquin Valley. A mild irrigation deficit in early navel oranges produced a significant yield loss that was not seen in an earlier study. Although alfalfa yield recovered after normal fall irrigation, citrus growers risked a 10-20% yield loss in the earliest navel oranges with even mild stress.

Blake has done an outstanding job in tackling research projects NO ONE, including the faculty and Extension Specialists, were capable of doing on their own. Two such projects are the almond nitrogen and potassium fertilization project lead by Dr. Patrick Brown, Professor, UC Davis Department of Plant Science, at Wonderful Farms, and Blake's pistachio rootstock/salinity project with Mr. Starh, a cotton grower transitioning to tree crops south of Buttonwillow. These were HUGE projects in size and time demand. Blake secured the cooperation of the growers, and then went into the field with his assistants to establish and oversee the project.

The pistachio rootstock/salinity project involved 310 acres and MILES of irrigation pipe that he and research assistant, Beau Antongiovanni, personally installed. They then established 0.5, 2.5, and 5.0 ds/m irrigation water to test its long-term effects on the two most commonly planted rootstocks, UCB-1 and Pistacia integerrima (Pioneer Gold 1). The grower soon saw the growth reduction from the 5.0 ds/m water and wanted to terminate this treatment. Blake successfully negotiated keeping this critical treatment by reducing the size of each replicated plot. However, this came at great physical expense to Blake, who re-plumbed 13,000 additional feet of pipe to maintain the integrity of the trial! Such is the dedication and determination of Blake Sanden! The result from this 10-year project yielded individual production functions for each rootstock, and established 5ds/m as a long-term soil salinity threshold at which yield would not be affected.

Armed with his salinity results on newly planted trees, Blake was a key contributor to another project led by Dr. Daniele Zaccaria, LAWR Extension Specialist, and then Post-doctoral Scholar, Giulia Marino (now a UC Extension Specialist) on the assessment of pistachio water use in saline soils using Eddy Covariance. Blake contacted me for assistance in locating research sites, because he had intimate knowledge of pistachio culture, and knew what requirements to look for. Blake and I toured Kings County for almost a day looking at possible locations. Once located, I did the initial introduction to the grower to secure their cooperation. Blake then followed through to ensure that the promises made were kept. When the specialist was out of the country during harvest, Blake was the one who came to the rescue to get the cooperation of the grower and harvest the trial. This is no small task these days, because time is money to these custom harvesters, and they do not get paid for messing around gathering individual tree yields in garbage cans with Extension people. It's safe to say Blake was THE go-to guy for assessment and explanation of the problem salinity creates for tree nut crops

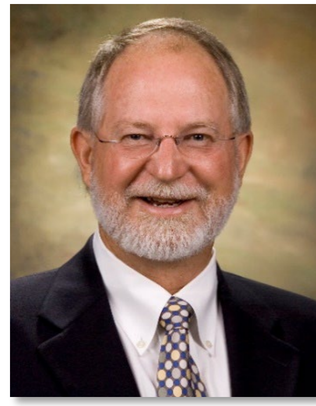
Blake is also an outstanding teacher, with 200 Extension presentations in the past 13 years. In many ways, Blake has served as a specialist in the southern San Joaquin Valley, because of his direct experiences with his assigned subject matter, and the depth of his knowledge. Soil and water science has a host of terms, abbreviations, and equations associated with solving salinity and infiltration. Blake has worked extremely hard to teach growers and allied industry people how to understand soil analyses and apply the proper amendments. He always patiently listens to the analysis numbers and our plan, and then offers his thoughts in agreement or opposition to it. If he disagrees, he teaches you why. Blake has also served on many advisory committees; he has been a board member for the California Irrigation Institute, the oldest continuous water forum for over 15 years. In 2017, he was honored as the Irrigation Person of the Year. He has authored 16 peer-reviewed publications during the latter half of his career, as well as scores of technical and county-based research reports, detailed newsletters, and a comprehensive website filled with how-to information.

Blake is also a very fine individual, having represented UC and agriculture with class and without discrimination to anyone. I see Blake as a very fair fellow, one who has worked hard at being a peacemaker. Blake did not find it difficult to subscribe to the UC policies of Affirmative Action, because he has a kind and unbiased heart molded by his faith. Anyone having served as a missionary, and contracted malaria several times while working to elevate the standard of living for those less fortunate than us Americans certainly understands the essence of equality.

In conclusion, given all the outstanding research and knowledge Blake has contributed to UC and California agriculture, I am truly honored to be the one blessed with the opportunity to share his career with the American Society of Agronomy, who recognizes the significance of his contributions to precision irrigation and soil management. I join Society members today in honoring you for your distinguished service to the Society and the California farmers responsible for insuring a safe, abundant food supply. Congratulations, Blake!

Bruce A. Roberts

Presented by Phillip Smith



“If one believes education is an end, then he doesn’t understand the meaning of means and ends” (A. Saint-Exupery). In 1975, Bruce Roberts defined his career objective and his reason for applying to the graduate program at Utah State University: “I believe a career in Cooperative Extension would be an excellent foundation to prepare one for college teaching”. This belief/hypothesis was formed by his fortunate opportunity to augment his classroom education at Fresno State by summer employment with Fresno County U.C. Cooperative Extension advisors. During these formative years, professors prepared him academically while summers spent with advisors Don May, Les Stromberg, and Bill Fisher introduced him to applied research and how important knowledge is to solving problems in production agriculture. Bruce also developed friendships with individuals whom he would work closely with during his extension career.

Raised in Chowchilla, CA, Bruce is the son of parents who migrated to California from Arkansas as the New Deal and WW II shaped the future of this country. His father arrived with the Civilian Conservation Core (CCC) program and enlisted in the US Army when the war broke out. His mother arrived on the west coast as an 18-year-old wife of a soldier traveling east to the European Theater. She lived with her parents in Berkeley who had also moved to California to build ships for the war effort. After the war, his parents moved from Oakland to the central valley where other relatives had settled, and the countryside showed great promise. Bruce was exposed early to agriculture from his father’s involvement in dry-land farming and a 40-acre irrigated family farm. An Elberta peach orchard was planted on half the acreage. On the open ground, his father grew cotton, a crop that was to become a significant interest to Bruce in his later career.

After high school, Bruce held various jobs while attending Fresno City College until he was drafted in 1969. Following his tour of duty with Uncle Sam, Bruce returned to Fresno City with a renewed hunger for education fed with his GI Bill. Completing his AA degree, he was accepted to Humboldt State where he enrolled in a course on conservation of natural resources. It was in this course that he was made aware of the science of soils and of the importance this resource is to society. Because of this new awareness plus the distance from where his future wife Amy resided, he transferred to Fresno State’s Plant Science Department. He received the Soil Improvement Committee’s scholarship thanks to Jim Brownell’s soils class, and his career trajectory was set.

Bruce graduated from Fresno State in 1975, then pursued graduate studies at Utah State University where he completed a master’s degree in Soil-Plant-Water Relations. His first job following graduate school was with Basic Vegetables in King City, CA. He was a member of the research group conducting applied research on onions and garlic. This position, while narrow in its work with alliums, broadened his geographic experience with western agriculture. He conducting field trials from Imperial County to Monterey County. While with Basic, the Cotton Farm Advisor position in Kings County opened for recruitment. Bruce applied and was hired, thus began his career with Cooperative Extension in Kings County.

During the two decades Bruce served as Farm Advisor in Kings County, California experienced two major floods and two long droughts. These were exceptionally challenging times for California farmers, especially for growers in the Tulare Lake bottom. Flooding disrupted crop rotations and late spring rains caused delayed plantings with outbreaks of seedling diseases. The droughts forced researchers and growers to explore means of conserving irrigation water. Practices and limitations that have continued to challenge California farmers. The extension program Bruce conducted in Kings County addressed many production constraints related to agronomic crops produced in the San Joaquin Valley. Applied field research and extension outreach meetings addressed issues of seedling disease, soil fertility, variety evaluations, pest management practices, pre-harvest preparations and storage of moduled seed-cotton. Evidence of Bruce's extension efforts are reflected in changes of cotton lint yields over those 20 years. Average lint yields, as reported in the Kings County Crop and Livestock Reports rose from 2 bales in 1983 to 3 bales per acre in 2004 - a 47 percent increase in cotton lint yields across the county. By 2004, there were several growers reporting 4 bale per acre yields from new varieties and careful/better management practices. Bruce's extension program was also involved with the introduction of new crops. Garbanzo beans was introduced as a viable alternative to winter cereals, and Kings County played a significant role in the acceptance and approval of long-staple Pima cotton for the San Joaquin Valley (SJV).

"Working with plants and soils is rather straight forward, working with people is the challenge." Bruce faced some "challenging people" during his extension and academic years. He was "at odds" with many of the UC entomologists about the importance of early-season pest control. The IPM approach discounted early foliar damage as cosmetic. Bruce showed through growth chamber studies, field trials, and in-field root system evaluations that early thrip damage reduced overall production. Today early season control of thrips is an accepted practice across the US Cotton Belt. Of all his professional activities, Bruce is most proud of his collaborative work other scientists. In soil fertility: Teaming up with Ken Cassman and his graduate students at UC Davis was an exciting and challenging opportunity to resolve a long-standing controversy on potassium fertility. The nitrogen work coordinated with UC Davis and UCCE farm advisors was incredibly productive and contributed to his future research interests. Bruce also collaborated with a group of scientists from the National Oceanic and Atmospheric Admin. on an energy balance study of irrigated cotton. His association with the National Aeronautics and Space Admin. (NASA) introduced precision agriculture tools to the SJV. Bruce conducted the first variable rate nitrogen and defoliation studies on cotton in the SJV. Both field studies utilized state-of-art technology of aerial imagery and ground application equipment to demonstrate improved efficacy of applied variable rate treatments and cost savings. The Precision Ag Field Days held in Kings County drew over 300 participants.

In 1998, Bruce was granted a sabbatical leave to attend UC Davis where he was accepted into the Graduate Group of Ecology. His dissertation research delved into the domain of soil ecology. Using microbiology and chemistry, he partitioned and quantitatively measured the decomposition products produced by distinct microbial groups. Using cotton residues labeled with nitrogen (N15) he followed the mineralization of plant residues into organic pools over a three-year cropping cycle. He demonstrated that different microbial communities dominated specific soil types, which influenced the decomposition of crop residues at different rates and produced quite different residual pools of conserved nitrogen. The different carbon/nitrogen ratios and solubilities of these organic fractions affects the stability of soil organic matter. His research elevates the specific importance of biological contributions to H. Jenny's soil formation processes.

Following his year at UC Davis, Bruce realized the opportunity to make the transition to complete his earlier career goal. The J.G. Boswell Chair of Agronomy was created at Fresno State and the recruitment process had begun. He applied for the position and was selected to be the first holder of the endowed chair in the Plant Science Department. Thus, his decade of teaching began.

While at Fresno State, he taught classes focused on soil and agronomic production with an ecological emphasis. Bruce encouraged students to reinstate the Plant Science Club and become active in attending national meetings and applying for society sponsored scholar programs. He also encouraged students to become active in the national soil judging competition and helped formed the Soil Judging Team. He developed ties with industry to support student involvement and travel to these professional opportunities. In 2010, Bruce was selected as a Fellow of the American Society of Agronomy, and in 2015, he received the Salgo-Noren Outstanding Teacher Award for the College of Agriculture Science and Technology. He continued his research interests through overseeing graduate student's thesis and hiring a post-doc scientist and team to develop a life-cycle carbon footprint model for the pistachio industry. Bruce was honored to be the faculty advisor for Alpha Gamma Rho, the national agriculture fraternity. He served this role for 10 years and developed a sincere appreciation for this exceptional group of young men.

Bruce Roberts spent the last decade of his career testing his early hypothesis that an extension career would be a beneficial foundation to prepare one for college teaching. It turned out to be an excellent foundation for training the future generation of agriculture producers, scientists, and life-long learners for California. Bruce is honored to have known and worked with such a brilliant and dedicated group of scientists, farmers, and students over his career in extension and teaching. His involvement with these men and women has been inspiring and encouraging. His hope is that those he has encountered will realize that education is not an end, but a life-long means to a good and satisfying life and that some of his lessons will be helpful in solving future challenges.

Bruce is a past president of CA ASA (2005) and served previously on the board of directors. His research has been presented in book chapters, scientific publications, and at international symposiums, national conferences, and statewide professional meetings. He retired in 2016 and has turned his interests to pursuits he has always wanted to do. Travel to exotic places and painting watercolor landscapes are his new goals. In retirement, Bruce plans to paint his masterpiece.

Agenda

Tuesday, February 1

8:00 AM	Florence Cassel, CA-ASA President, Introduction	
Main Session		**Chairs: Florence Cassel and Michelle Leinfelder-Miles**
8:10	Introductory Remarks	
8:15	**Drought: What's Old is New Again**—*Jeanine Jones, Interstate Resources Manager, CA Department of Water Resources*	
8:45	**Flood Mar at Terranova Ranch**—*Don Cameron, General Manager, Terranova Ranch, Inc. and President, California State Board of Food and Agriculture*	
9:15	**California's and the San Joaquin Valley's Uncertain Water Future**—*Sarge Green, Research Scientist, CA State University, Fresno*	
9:45	Discussion	
10:05	Break	
Session 1: Strategies for Increasing Farm Water Conservation: Perspectives from Growers and Practitioners		**Chairs: Michael Cahn and Mae Culumber**
10:20	**Opening Remarks**	
10:25	**Increasing Water Conservation and Nutrient Efficiency Through SWEEP and HSP Grants**—*Aparna Gazula, UC Cooperative Extension*	
10:40	**Challenges to Improving Irrigation Management on a Central Coast Vegetable Farm**—*Mark Mason, Huntington Farms*	
10:55	**Using Technology to Make Informed Irrigation Decisions: If You Can't Measure It, You Can't Measure It**—*Brandon Rebiero, Gold Leaf Farming*	
11:10	Panel Discussion	
11:40	Lunch Break	
Session 2: Crop Tolerance to Heat, Drought, and Deficit Irrigation		**Chair: Lauren Hale**
12:30 PM	**Opening Remarks**	
12:35	**Lessons from the Field: How Sorghum and Its Microbiome Respond to Drought**—*Peggy Lemaux, UC Berkeley*	
1:00	**The Impact of Deficit Irrigation on Almond, Walnut and Pistachio Nut Crops**—*Robert Beede, UC Cooperative Extension*	
1:25	**Drought Tolerance Traits for Grape Rootstocks**—*Megan Bartlett, UC Davis*	
1:50	Break	

Student Oral Presentations and Competition	Chairs: Nick Clark, Mark Cady and Ranjit Riar
2:00	Undergraduate and M.S student presentations

Wednesday, February 2

Session 3: Current Issues and Advancements in Weed Management	Chairs: Ranjit Riar and Gina Colfer
8:00 AM	**Opening Remarks**
8:05	**The Increasing Prevalence of Palmer Amaranth and Common Waterhemp in the Central Valley**—*Anil Shrestha, CA State University, Fresno*
8:30	**New Technologies for Weeding in High Value Vegetable Crops**—*Pauline Canteneur, FarmWise Technologies*
8:55	**Common Rush Management in Irrigated Pastures Using Wick Wiper and Roundup**—*Ranjit Riar, CA State University, Fresno*
9:20	Break
Session 4: Hot Topics in Pest Management	**Chairs: Jacob Wenger and Marja Koivunen**
9:35	**Opening Remarks**
9:40	**Impact of Climate Change on Navel Orangeworm, Amyelois Transitella**—*Jhalendra P. Rijal, UC Cooperative Extension*
10:05	**Responding to the Growing Threat of Impatiens Necrotic Spot Virus (INSV) Affecting Lettuce in the Salinas Valley**—*Daniel K. Hasegawa, USDA-ARS*
10:30	**Evaluation of Chemical Control Strategies for Branched Broomrape in California processing tomatoes—***Matthew Fatino, UC Davis*
10:55	Break
Session 5: Biostimulants	**Chairs: Eric Ellison, Mark Cady, and Marja Koivunen**
11:10	**Opening Remarks**
11:15	**Biostimulants from a Regulatory Perspective**—*Nick Young, CA Department of Food and Agriculture*
11:40	**Soil and Plant Microbiomes: Complex Ecosystems that Harbor Novel Plant Growth Promoting Bacteria**—*Ann Hirsch, UCLA*
12:05 PM	**Biostimulants and Factors Affecting Crop Responses**— *Michael Rethwisch, UC Cooperative Extension*
12:30	Lunch

CA-ASA Business Meeting	Florence Cassel presiding
1:00	Opening Business Items
1:20	Announcement of Student Scholarship Awards
1:30	Announcement of Student Oral Presentation Awards
1:45	Presentation of Awards to 2022 Honorees
2:15	Closing Business Items

Thursday, February 3

Session 6: Irrigation Under Drought Conditions	Chair: Michael Cahn, Mae Culumber and Florence Cassel
8:00 AM	**Opening Remarks**
8:05	**Understanding How Drought May Affect Your Irrigation Pump**—*Bill Green, CA State University, Fresno*
8:30	**Water Management Considerations for Tree Crops Under a Limited Water Supply**—*Allan Fulton, UC Cooperative Extension*
8:55	**Management of Salinity Under Drought Conditions**—*Sharon Benes, CA State University, Fresno*
9:20	Break
Session 7: Soil Conservation	**Chairs: Lauren Hale and Sarah Light**
9:35	**Opening Remarks**
9:40	**Opportunities for Carbon Sequestration in California Soils**—*Jennifer Pett-Ridge, Lawrence Livermore National Laboratory*
10:05	**Putting Compost Into Context**—*Matt Cotton, Integrated Waste Management Consulting and Neil Edgar, California Compost Coalition*
10:30	**Predicting the Long Term Impact of Wood Biomass Applications on C Storage in Agricultural Soils**—*Mae Culumber, UC Cooperative Extension*
10:55	Break
Session 8: Nutrient Management	**Chairs: Nick Clark and Daniel Geisseler**
11:10	**Opening Remarks**
11:15	**Nitrogen Fertility in Common Beans Following Whole Orchard Recycling**— *Michelle Leinfelder-Miles, UC Cooperative Extension*
11:40	**Potentials of Legumes as Food and Cover Crop in California's Cropping Systems**—*Hossein Zakeri, CA State University, Chico*
12:05 PM	**Onion Response to Irrigation and Nitrogen Rates**—*Jairo Diaz, UC Cooperative Extension*
End of Conference	

Main Session

Chairs: Florence Cassel and Michelle Leinfelder-Miles

Drought: What's Old is New Again

Jeanine Jones, Interstate Resources Manager, CA Department of Water Resources

Drought is a normal feature of California hydrology. Recent (21st century) droughts have been occurring in a climatic setting of increased temperatures, which increases drought impacts on managed and unmanaged systems. California's extensive system of water infrastructure was developed to respond to the state's large temporal and spatial variability in precipitation and has successfully limited drought impacts for most urban water users. The state has experience in managing drought impacts, and lessons learned from past droughts have resulted in statutory, regulatory, and policy changes. The state's present drought conditions reinforce the need to shift from thinking of drought as an episodic emergency toward a mindset of improving resilience under drier climate conditions. Investments in both data and infrastructure are needed to improve preparedness for a future with greater climate extremes and increased aridity.

Flood Mar at Terranova Ranch

Don Cameron, General Manager, Terranova Ranch, Inc. and President, California State Board of Food and Agriculture

Updates on progress of various ways Flood Mar projects on Terranova Ranch. From flooding agricultural fields including almonds, walnuts, pistachios, and wine grapes to groundwater recharge using dry wells and the reasons for doing each.

California's and the San Joaquin Valley's Uncertain Water Future

Sargeant J. Green, Research Scientist, CA State University, Fresno and California Water Institute

The recent trends in greater variability of surface water combined with the long-term over extraction of groundwater in many areas of California, but especially the San Joaquin Valley, has put agriculture and other users of water in a precarious and uncertain future. The Sustainable Groundwater Management Act (SGMA) is the tool designed to arrest overdraft but implementation has just begun and the full impacts unknown. Some areas have adopted pumping allocations and users in those areas will have to make difficult decisions. Agriculture will undoubtedly feel the brunt of those decisions. While these uncertainties are daunting, there is an over-riding need to address certain issues. These needs require the water community to be more collaborative than ever before. The issues include the following:

Rural drinking water – failing small water systems and dry individual domestic wells will need to be addressed as a matter of conscience and common sense. Private or community wells in aquifer systems may need to be deepened at the expense of the larger groundwater community. This does not involve very much water. Mountain and foothill areas need common sense evaluation, very low flow areas should be avoided as a health and safety matter.

Groundwater recharge – we need to finish the qualifications process of the best areas for recharge. The sooner the process is done the sooner we can finish calculations of how much water we can sensibly put into the ground which in turn illuminates the investments needed to convey or store such water.

Recycling – areas that currently rely on surface water and discharge wastewater or storm water to the ocean need to finish the planning and receive financing as quickly as feasible to recycle water for logical uses such as groundwater recharge, direct potable reuse or environmental restoration and enhancement.

Addressing these issues will require collaboration at a scale the water community has not risen to in the past. One area of promise that forces the issue are the basin or sub-basin coordination agreements required under SGMA.

Session 1: Strategies for Increasing Farm Water Conservation: Perspectives from Growers and Practitioners

Chairs: Michael Cahn and Mae Culumber

Increasing Water Conservation and Nutrient Efficiency Through SWEEP and HSP Grants

Aparna Gazula, UC Cooperative Extension, Santa Clara County

The Budget Act of 2021 has allocated $50 million to CDFA's State Water Efficiency and Enhancement Program (SWEEP). SWEEP provides financial incentives to California growers and ranchers to invest in irrigation and water pumping systems that reduce on-farm water use and reduce greenhouse gas emissions. The maximum grant amount is $200,000 per application cycle and a maximum limit of $600,000 per agricultural operation (applications submitted in different funding years are for system improvements on non-overlapping APNs).

Similarly, CDFA's Healthy Soils Program (HSP) has received $50 million from the State General Fund and $25 million from the California Climate Investments for the HSP Incentives Program and Demonstration Projects. CDFA HSP Incentives Program provides financial incentives to California growers and ranchers for implementation of agricultural management practices that sequester carbon, reduce atmospheric greenhouse gas emissions, and improve soil health. The maximum grant amount is $100,000 per application cycle.

These two programs have received unprecedented funding in the Governor's Budget for the next two years. Through fiscal year 2022-2023, SWEEP received $100 million and HSP received $160 million.

One-on-one technical assistance with grant application is available through CDFA's SWEEP and HSP Climate Smart Agriculture Technical Assistance Program. In this presentation I will address the application preparation process and some of the key practices that have been funded in the past.

Challenges to Improving Irrigation Management on a Central Coast Vegetable Farm

Mark Mason, Huntington Farms

Irrigation and nitrogen management on central coast vegetable crops is very complicated and can be very complex at times. There are many moving parts in the production system and it can be difficult to schedule irrigations and track water volume at a planting level. This is a basic understanding of a central coast production model, why irrigation and nitrogen management can be so complex and what we are doing to try to overcome these challenges.

Using Technology to Make Informed Irrigation Decisions: If You Can't Measure It, You Can't Measure It

Brandon Rebiero, Gold Leaf Farming

During this presentation, I will share three technology tools I use at Gold Leaf Farming that create actionable data and informed decision making. Ag Tech is a very crowded space and it takes a lot of trial and error to distinguish 'nice to have' from actionable. There are three legs to the irrigation stool I will discuss today: ET, ground truthing, and root tension. Each of these helps in conserving water and optimizing yields.

Session 2: Crop Tolerance to Heat, Drought, and Deficit Irrigation

Chair: Lauren Hale

Lessons from the Field: How Sorghum and Its Microbiome Respond to Drought

Peggy Lemaux, UC Berkeley

Studying the impact of drought and approaches to mitigate its effects is important because of the increased frequency and severity of this abiotic stress with climate change. The focus of our DOE-funded project was studying the responses in the field of sorghum [*Sorghum bicolor* (L.) Moench], a C4 cereal crop, and its microbiome to drought. Sorghum is noted for its drought tolerance. So, in this multi-year field experiment, we explored plant and microbial responses under fully irrigated and two different drought stress regimes in replicate plots of two sorghum genotypes, differing in pre- and post-flowering drought responses. These studies were conducted in fields in California's Central Valley, where rare summer rainfall permits controlled drought conditions. Leaf, root and soil samples were taken weekly over the plant's lifetime to attempt understanding the cellular mechanisms functioning in the acclimation and recovery of sorghum from pre- and post-flowering drought. To gain additional insights into drought responses, impacts of this abiotic stress were also studied in microbial populations.

Composition of fungal and bacterial communities, associated with these same plants, led to additional comprehensive data that were used to understand the impact of these relationships on the drought response of sorghum. The multi-year field data is presently being used to devise models to better predict and control the roles and interactions of plant gene regulation and the microbiome in sorghum's response to drought.

The Impact of Deficit Irrigation on Almond, Walnut and Pistachio Nut Crops

Robert H. Beede, UC Cooperative Extension, Farm Advisor, Emeritus

Although almond, walnut and pistachio are all botanically classified as drupes due their shared fruit structure, they differ from one another in their response to deficit irrigation. A brief summary of the research identifying these differences, and discussion of opportunities for regulated deficit irrigation will be presented.

Drought Tolerance Traits for Grape Rootstocks

Megan Bartlett, University of California, Davis, Dept. of Viticulture and Enology

Gabriela Sinclair, Gabriela Fontanesi, Gianna Disco, Celeste Arancibia, Thorsten Knipfer, Andrew McElrone, Andrew Walker

Drought tolerant rootstocks are an important management tool to maintain grape yield and quality under dry conditions. Our goal was to identify traits that confer rootstock drought tolerance to amplify in future breeding efforts. We focused on traits characterizing the responses of the living cells in the root to water stress. These cells are a critical bottleneck for water uptake from dry soil, but these traits had never been evaluated for a role in rootstock drought tolerance. We conducted two greenhouse experiments, using a range of commercial rootstocks (110R, 140-Ru, 1103P, Ramsey, 101-14, 420A, 5C, and Riparia Gloire) grafted onto the same scions (Chardonnay and Cabernet Sauvignon). Root capacitance (C) and turgor loss point (TLP) were significantly different across rootstocks and watering treatments in experiment 1 (8 rootstocks × Chardonnay), but only TLP differences were significant in experiment 2 (4 rootstocks × Cabernet). Rootstocks with a lower *C*, which indicates the roots retain more water as root water potentials decline, maintained greater photosynthesis under water stress ($p < 0.001$). Rootstocks with a more negative TLP, which indicates the roots undergo cell collapse at more negative water potentials, produced larger root systems and maintained greater whole-plant transpiration ($p < 0.001$). Rootstocks' TLP values were well correlated between experiments ($r^2 = 0.59$, $p = 0.02$), but not C ($r^2 = 0.04$, $p > 0.05$). Overall, these findings suggest that breeding for reduced TLP and C would improve drought performance in grape rootstocks, and that TLP is a reliable trait across different scions and growing conditions.

Session 3: Current Issues and Advancements in Weed Management

Chairs: Ranjit Riar and Gina Colfer

The Increasing Prevalence of Palmer Amaranth and Common Waterhemp in the Central Valley

Anil Shrestha, California State University, Fresno

Katherine Waselkov, California State University, Fresno

Palmer amaranth (*Amaranthus palmeri*) and common waterhemp (*A. tuberculatus*) are ranked as the top problematic weeds in the US by the Weed Science Society of America, primarily because of their invasiveness and resistance to several herbicide modes of action in annual cropping systems. Although these species were in low prevalence in California, in recent years, they are being noticed more commonly in annual and perennial cropping systems in the Central Valley. A glyphosate-resistant (GR) population of Palmer amaranth has been confirmed in the Valley and studies are underway on common waterhemp. The germination ecology, competitiveness, and genetics of both these species, including the GR and glyphosate-susceptible (GS) types, are being studied. Alternative postemergence herbicides for the control of these species are also being tested. Preliminary results show that although the germination response of GR and GS Palmer amaranth to environmental stresses such as moisture, salinity, and pH are similar, the GR plants are more competitive than the GS plants with young grapevines. Since there is no confirmed GR population of common waterhemp yet, the germination ecology and efficacy of some common postemergence herbicides at different growth stages of local population plants is being studied. Preliminary results from analysis of genotyping-by-sequencing data for waterhemp show the presence of genes from both western (*A. tuberculatus* var. *rudis*) and eastern (*A. tuberculatus* var. *tuberculatus*) subspecies of waterhemp in Merced County, but reduced genetic diversity and variation compared to the Midwestern native range of the species. Genomic data is still being collected and analyzed from a broad survey of Palmer amaranth populations in the native Southwestern range, the invaded Eastern U.S. range, and the invaded Central California range, to identify the source of the California populations.

New Technologies for Weeding in High Value Vegetable Crops

Pauline Canteneur, FarmWise Technologies

5-year old farm robotics company FarmWise developed a mechanical system for weed control that uses computer vision to detect crops from weeds in the intra-row in lettuces, broccoli, cauliflower, celery, and artichoke. Up to six pairs of robotics arms attached to a y-axis bar that moves with three degrees of freedom actuate blades in the ground. Actuating blades open and close around the crops while a set of fixed blades takes care of the inter-row. The company's database consists of millions of crop images taken in various fields and soil conditions across the Salinas, Yuma, and Imperial Valleys as well as the Oxnard Plains. Deep learning models have been trained on these images and are dictating the movement of each blade in the ground. Headquartered in Salinas, FarmWise today deploys fourteen machines, charging growers a fee per acre for the weeding service.

Common Rush Management in Irrigated Pastures Using Wick Wiper and Roundup

Ranjit Riar, California State University, Fresno

Many California irrigated pastures are infested with common rush (*Junucus effusus* L.). Also known as soft rush or wireweed, it is a perennial weed that is easily spread by wind and irrigation water carrying the seeds from established plants in or near the irrigation network. Once established, it grows about three feet tall, with wide dark green clumps. Cattle tend to stay away from areas of the pasture with heavy infestation. Seed shed from mature rush plants, and new seed introduction with canal water can continue to increase the density of the weed. This reduces the quantity and quality of forage available for the cattle grazing on these pastures and decreases their carrying capacity. A research trial was set up on the Fresno State University Agricultural Lab irrigated pasture during the summer of 2019 and 2020. Roundup solution at 25, 50, and 75 % concentration was applied using a wick applicator pulled behind an ATV, using a single pass, and compared with an untreated control. Chlorosis, necrosis and weed mortality were evaluated at 3, 7, 14, and 21 days after treatment. Later evaluations were also done at 6 and 11 months after the treatments.

Roundup takes about 14 days to kill a grass plant completely, but that time was longer for common rush. Maximum average chlorosis (yellowing or lack of green color compared to control) was 47% after 11 days for 50 % treatment, and 50 % after 7 days for 75 % treatment. Higher concentration of 75 % led to a quicker yellowing but did not differ in overall control. Necrosis (dead leaf tissue) was noticed 11 days after application for all treatments and reached values of 38 % and 90 % for both 50 and 75 % solutions at 1 and 6 months after treatment, respectively.

Session 4: Hot topics in Pest Management

Chairs: Jacob Wenger and Marja Koivunen

Impact of Climate Change on Navel Orangeworm, *Amyelois Transitella*

Jhalendra P. Rijal, UC Cooperative Extension

Tapan Pathak, University of California, Merced

Climate change is the long-term change in climate parameters due to increases in greenhouse gas (GHG) emissions in the Earth's atmosphere. California's future temperature is predicted to be increased by 2-70C by the end of the 21st century. In a biological sense, the significant impacts of climate change parameters – unpredictable precipitation, elevated atmospheric carbon dioxide, and increased temperature – are evident in plants and organisms that rely on those plants. Insects are poikilothermic, and thus, their physiological and reproductive activities are highly influenced by the environmental temperature. The increased temperature under climate change can result in better winter survival, a higher number of generations, heightened pest pressure in agricultural crops, a widening geographic range, and more. Recently, we conducted a study to quantify the impacts of the predicted increases in temperature to navel orangeworm, *Amyelois transitella* population in California's Central Valley. Navel orangeworm is the most notorious pest of three major nut crops, almond, walnut, and pistachio, which occupy >2 million acres in the Valley. We selected 23 Central Valley counties for this study and used temperature data (max/min) derived from 10 climate models (GCMs or "General Circulation Models) to project the navel orangeworm phenology. The results showed that navel orangeworm is estimated to complete its life cycle in a shorter duration under climate change. The study also predicted to increase the number of generations from current 3-4 generations to five generations as early as 2040 in a few counties. That scenario is increased to 21 of 24 counties studied by the end of the century. This study may help the high-value crop industries to initiate some dialogue around this topic to strengthen navel orangeworm integrated pest management (IPM) strategy for the future.

Responding to the Growing Threat of Impatiens Necrotic Spot Virus (INSV) Affecting Lettuce in the Salinas Valley

Daniel K. Hasegawa, USDA Agricultural Research Service

Richard Smith, University of California Cooperative Extension, Monterey County; Laura Hladky, USDA Agricultural Research Service; Alejandro Del-Pozo, Virginia Tech University

Lettuce production in the Salinas Valley was severely impacted by impatiens necrotic spot virus (INSV) from 2019 to 2021. Research to understand the epidemiology of INSV and its insect vector, the western flower thrips, *Frankliniella occidentalis*, is ongoing and urgently needed to develop best management practices. This presentation will provide an update on the knowledge that has been gained from research on thrips and INSV over the last several years. Topics include Salinas Valley monitoring strategies for thrips, field surveys to identify alternative host plants of INSV, and other studies to understand the re-emergence of the virus in the region. This research addresses the pressing need to understand the epidemiology of thrips and INSV, which have had major economic impacts on lettuce production on the Central Coast of CA.

Evaluation of Chemical Control Strategies for Branched Broomrape in California Processing Tomatoes

Matthew Fatino, University of California, Davis, Dept. of Plant Sciences

Brad Hanson, University of California, Davis, Dept. of Plant Sciences

Recent detections of branched broomrape (*Phelipanche ramosa*) in California tomato (*Solanum lycopersicum*) fields have led to increased interest in herbicide treatment programs to control this regulated noxious weed. Broomrapes (*Phelipanche spp*. and *Orobanche spp*.) are parasitic weeds that pose a significant risk to the processing tomato industry for several reasons: California's Mediterranean climate is similar to that of branched broomrape's native range, California agronomic practices (wide variety of host species cultivated, successive tomato crops, shared equipment) make the proliferation and spread of broomrape in and among fields highly likely, and broomrape's phenological development makes it difficult to monitor and inaccessible to conventional weed control practices. In addition, California's regulatory environment make soil fumigation difficult and costly and herbicides unavailable, while branched broomrape's regulatory status as quarantine pest does not incentivize accurate reporting.

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 broomrape life stages. Research began in 2019 to determine if the PICKIT system could be adapted to manage branched broomrape in California processing tomatoes and to provide herbicide registration support data.

Treatment programs based on the PICKIT system were evaluated in 2019 and 2020 for crop safety on processing tomato. Treatments included several combinations of preplant incorporated (PPI) sulfosulfuron applications paired with different rates of imazapic either injected into the drip system (chemigation) or applied as foliar treatments. There were no significant differences in phytotoxicity or tomato yield among herbicide treatments in the three experiments. Additionally, a rotational crop study was conducted in which a tomato crop received PICKIT treatments in 2019 and several common rotational crops were planted and evaluated in 2020. Corn planted after the sulfosulfuron treatment suffered chlorosis and stunting, however, safflower, sunflower, melons, and beans were not injured by any of the treatments.

An efficacy study was conducted in 2020 to evaluate the efficacy of a modified PICKIT system in California growing conditions. The study took place in a commercial field in Yolo County reported to be infested with branched broomrape in 2019. This trial examined the efficacy of the sulfosulfuron and imazapic as well as imazapyr, imazethapyr, and imazamox for control of branched broomrape.

There were 12 treatments replicated four times, and 47 out of 48 plots (45 m^2) had broomrape emergence. On average, non-PICKIT treatments had 38 broomrape clusters per plot while PICKIT treatments had 13 clusters per plot. There was a trend in which the PICKIT treatments had fewer broomrape shoots per plot than the non-PICKIT treatments, however, there were no significant differences in the number of broomrape shoots among PICKIT treatments and none of the treatments completely eliminated broomrape emergence.

Imazapic faces a difficult registration pathway in California, and in 2021, another imidazolinone herbicide, imazamox, was evaluated in place of imazapic in a chemigation program. Two crop safety studies were conducted in 2021 to evaluate several combinations of preplant incorporated sulfosulfuron applications paired with different rates of chemigated imazamox. An additional efficacy study focused on imazamox was conducted in the same Yolo County infested commercial field in 2021. Imazamox injury was observed in the crop safety studies and included stunting, chlorosis, and leaf and stem discoloration; however, there were no significant differences in tomato yield among treatments in the two crop safety studies. There were no broomrape emergences in the efficacy study; the study was planted late (6/11/21) and followed by a severe heat wave, which may have contributed lack of broomrape emergence. Severe injury was observed in the efficacy study and there were significant differences in tomato yield, with the two highest rates of imazamox significantly reducing yield. Additionally, a rotational crop study initiated with tomato in 2021 will have rotational crops planted in 2022.

Session 5: Biostimulants

Chairs: Eric Ellison, Mark Cady, and Marja Koivunen

Biostimulants from a Regulatory Perspective

Nick Young, Environmental Program Manager, California Dept. of Food and Agriculture

The fertilizing material industry has a challenge with regards to the recognition and distribution of plant biostimulants in the United States. A lot of progress is being made towards the acceptance and standardization of biostimulant regulation within California and throughout the US. We'll examine the recent history, present status, and future direction of biostimulant regulation and how it may affect the industry.

Soil and Plant Microbiomes: Complex Ecosystems that Harbor Novel Plant Growth Promoting Bacteria

Ann Hirsch, University of California, Los Angeles

Our studies focus on soil and plant microbiomes from arid environments, particularly of legume root nodules using metagenomics and culture-based techniques to isolate and identify potential plant growth-promoting bacteria (PGPB). We also investigate the potential functions of the PGPB and non-rhizobial nodule-associated bacteria (NAB) towards finding microbes that positively influence plant growth and development. Our approach focuses on developing microbial consortia to replace or augment commonly used fertilizers, which are not only damaging to the environment but also becoming prohibitively expensive. The actinomycete *Dietzia cinnamea*, isolated from the Negev Desert (Israel) and not previously identified as a PGPG, is an example of an isolate that promotes both corn and wheat growth; the former up to 16% in Nebraska field tests. Although rhizobia are mainly isolated from alfalfa, fava bean, and cowpea nitrogen-fixing nodules, the majority of NAB were identified as Gram-positive Firmicutes, (*Bacillus*, *Paenibacillus*, etc.) and Actinobacteria (*Micromonospora*, *Streptomyces*). The isolates exhibit strong PGPB and antifungal activities and solubilize phosphate, produce siderophores, as well as grow at both low and high pH levels and produce a variety of hydrolytic enzymes, especially chitinases, which function in biocontrol. Ten strains were tested in coinoculation with N^2 fixing *Ensifer* on alfalfa, and strains of *Bacillus* and *Micromonospora* increased plant growth significantly over that of *Ensifer*-only inoculated plants.

Biostimulants and Factors Affecting Crop Responses

Michael Rethwisch, UC Cooperative Extension, Riverside County

Biostimulants have become more widely available in recent years, with multiple products becoming commercially available on an annual basis. Unlike pesticides, these products are not as extensively tested, and are often more challenging to use as they must positively interact with plant growth and often multiple other factors, which can be challenging for success. Field trials over the past 15 years have identified a number of these factors which affect crop response, which include crop, growth stage, product rate, surfactant used, desired crop response (ex. grain vs. vegetation), available nutrition and environmental stress.

Similar to pesticides and pesticide classes, there are broad groupings/type of biostimulants, however, each biostimulant product within a group/type may elicit different crop responses. Research trials have noted consistent positive and statistical yield increases results from several crop/product combinations, as well as combinations with little, no or even occasionally negative yield responses. Consistent positive response combinations include gibberellic acid-3 on legumes and some cool season forage grasses, and various biostimulants on dehydrator onions, the latter of which have noted over 5% yield increases.

Session 6: Irrigation Under Drought Conditions

Chair: Michael Cahn and Florence Cassel

Understanding How Drought May Affect Your Irrigation Pump

Bill Green, California State University, Fresno

With drought conditions affecting water supplies and contributing to changing aquifer water levels, understanding how the irrigation pump output and performance may be affected is critical to energy and water use efficiency. This talk will show attendees how to read a simple pump performance curve as well as give examples of how pump output can be affected. Brief explanations of what to look for at the pumping plant in terms of pressure and flow can be useful information.

Water Management Considerations for Tree Crops Under a Limited Water Supply

Allan Fulton, UC Cooperative Extension, Tehama County, Emeritus

Droughts challenge California farms, especially those that are predominantly permanent tree crops. Orchard crops have relatively fixed or hard annual water requirements and crop fallowing or rotation is not very practical. Historically, farms have relied upon groundwater pumping to offset shortages of surface water but with early implementation of the Sustainable Groundwater Management Act (SGMA, 2015), there is more uncertainty about groundwater availability.

Fortunately, California's irrigated agricultural industry has an arsenal of science and experience-based knowledge and tools to face this challenge. This presentation explores some of the knowledge and tools inside this cache and contemplates how to apply them to sustain permanent crop farms.

How impactful water shortages can be upon a farm in California depends upon the farm setting within a watershed and the institutional policies influencing the availability and cost of surface and groundwater. Not every farm will experience the same level of impact from drought so the implementation of water management strategies may vary widely. Successful water management strategies are likely to be multi-disciplined using knowledge from plant and soil sciences, engineering, business, economics, and other disciplines.

Studies have shown many orchards do not reach maximum production potential and others have shown yield response to applied water (water productivity) varies across regions, farms, and fields. Good recordkeeping, especially yield and applied water, may distinguish orchards with higher from those of lower water productivity and help prioritize them as sustainable, needing improvements to sustain, or unsustainable and candidates to remove from production and use the limited water more beneficially for the farm. Routine groundwater level monitoring in comparison to well depths is another practice to prioritize orchards. Soil, water, and plant nutrient evaluation may explain why some orchards are more sustainable than others. Efficient irrigation system design and routine maintenance helps ensure limited water is used productively. Knowledge of phenological crop growth stages and sensitivity to water stress along with use of tree water stress indicators may reduce water use while minimizing the impact or even improving crops. Improved varieties and root stocks, and pruning decisions, will be valuable when deciding to pull older orchards and replace them with new, more sustainable orchards. Successful drought management strategies will employ a suite of practices that maximize farm margin of return to applied water.

Management of Salinity Under Drought Conditions

Sharon E. Benes, California State University, Fresno

With a warming climate and declining supplies of surface and groundwater one might consider how we will manage salinity present in our soils or accumulating due to the use of more saline waters for irrigation. Leaching, the application of extra water (beyond that needed to bring the soil to field capacity) to create gravitational flow and downward movement of salts in the soil profile, remains the most effective tool for salinity management. Maintenance leaching is a conservative approach based on steady-state assumptions in which additional water is applied with most irrigations with the goal of keeping the soil salinity (ECe) below the established threshold for a given crop. With water scarcity, maintenance leaching may not be feasible for many growers. However, if salinity is high enough to reduce crop growth and evapotranspiration (ET), then application of the normal, non-stressed crop water requirement may, in fact, be providing leaching. Soil moisture sensing and/or soil sampling are useful tools to determine the extent to which water is moving downward in the profile and the soil depth where salinity is accumulating. When irrigation water supplies are very limited, reclamation leaching may be more feasible and practical. With reclamation leaching, salinity accumulates in the rootzone over the season and then leaching is conducted at the end of the season (ideally when soil nitrate levels are low) to reduce salinity in the root zone. Calculation of the depth of irrigation water required to bring the actual soil salinity down to a desired soil salinity will be discussed. Winter rains can also be factored into this calculation of reclamation leaching. Effective leaching requires adequate infiltration water which is a function of its salinity (ECw) and sodicity (SAR). In sodium-affected soils, amendments such as gypsum applied to irrigation water or the soil surface prior to leaching may be required in order to achieve effective leaching. Appropriate choice of crop cultivar, or rootstock for trees and vines, is another important management tool when salinity in soil or irrigation water is higher than desired. For many crops, varieties and/or rootstocks with higher salt tolerance are available which can allow for economic yield at soil salinities well above the established yield loss thresholds.

Session 7: Soil Conservation

Chairs: Lauren Hale and Sarah Light

Opportunities for Carbon Sequestration in California Soils

Jennifer Pett-Ridge, Lawrence Livermore National Laboratory

Since the dawn of agriculture, cultivated soils have lost a vast amount of carbon to the atmosphere. Investing in management practices that "repay our carbon debt" and rebuild soil carbon reserves in working lands is a key negative emissions strategy with possible co-benefits for sustainable food, fiber and biofuel production. However, the heterogeneity of natural dynamics in soils can lead to disparate responses in different environments; hence efforts to increase soil carbon storage do not reliably yield net CO_2 removal in every agricultural or geographic context. Here, we will discuss our team's recent findings regarding: 1) factors that shape how root and microbial carbon becomes persistent soil carbon, 2) the role of microbes and specific mineral types, 3) factors that most reliably predict a site's capacity for increased soil carbon, and 4) the quantity of CO_2 removal that is possible in CA (and the entire USA) given the most widely effective soil management practices. In CA, our model analyses suggest cover cropping and applying compost to range and row crops have the most potential to increase soil carbon (albeit with large uncertainty). However, carbon accrual can be mis-counted in amendment studies if system boundaries are not well-defined. Also, it is critical to account for losses of greenhouse gases (N_2O, CH_4) and changes in soil carbon with depth.

Of the potential soil carbon sequestration practices, promoting crops with deep rooting phenotypes may be a particularly long-lasting solution, since carbon stocks can be increased throughout deep soil profiles. Our results from 13C tracer studies in CA grasslands suggest a substantial portion of newly plant-fixed carbon, introduced to the soil system via roots, becomes rapidly associated with mineral surfaces—and has the potential to become long-term stabilized. An extended analysis of sites where deep-rooted prairie grasses have been cultivated suggests that deep roots reliably introduce new carbon into the soil, but soil carbon turnover increases as the input rate increases and the effect of deep root inputs tends to be largest in soils with initially low carbon stocks. Overall, our results indicate that carbon farming strategies need to be matched to site conditions.

Putting Compost into Context

Matt Cotton, Integrated Waste Management Consulting and Neil Edgar, California Compost Coalition

This decidedly non-academic presentation seeks to provide an update on recent legislation and regulatory developments transforming commercial composting facilities and markets. These two seasoned composting professionals will explain the context of CA's recent landmark legislation SB 1383 and its likely impact on the availability and quality of compost. The presentation will cover recent regulatory developments, the state of CA's compost infrastructure, and issues facing California's compost industry and markets.

SB 1383 is an aspirational law that seeks to divert significant additional organics (largely food scraps) from landfill disposal. Despite a robust composting infrastructure, CA will need additional processing capacity and increases in market capacity to reach the state's ambitious goals. Available feedstocks will continue to grow as new collection programs are implemented statewide. New processing technology and new collection programs pose new challenges to feedstock quality. A study conducted by Cotton (2019) documented that agriculture is 65 percent of the market for CA's compost. Roughly 2.5 million cubic yards of compost is currently produced and is expected to increase significantly over the next decade.

SB 1383 Infrastructure and Market Analysis Report (DRRR-2019-1652), CalRecycle 2019.

Predicting the Long Term Impact of Wood Biomass Applications on C Storage in Agricultural Soils

Mae Culumber, UC Cooperative Extension, Fresno

Suduan Gao, Amisha Poret-Peterson, Greg Browne, USDA-ARS; Emad Jahanzad, California Dept. of Food and Agriculture; Amelie Gaudin, David Robles, UC-Davis; Brent Holtz, Cameron Zuber, Mohammad Yaghmour, Franz Niederholzer, Phoebe Gordon, UC Cooperative Extension

Whole orchard recycling (WOR) incorporates orchard waste on-site without moving debris to another location. Replicated trials were established at eight locations spanning the Central Valley to compare soil and tree growth responses to WOR applications (35 to 85 dry wt. tons/ac) and controls (no biomass additions) in different soil types and climate regimes. First year monitoring resulted in significantly higher soil organic matter, active soil C, microbial respiration C, and organically bound soil N at several sites, with others trending above the control. Tree growth and nutrition was similar to trees grown under control conditions at all sites. Detailed decomposition analysis and surface CO_2 and N_2O flux monitoring at two trial locations show rapid turnover in the first season after WOR, with drastic reduction in years two and three. An elevated nitrogen emission factor (EF%) was observed in response to fertigation events in the first season due to the abundance of labile C from freshly applied wood biomass. The N_2O decreased in years two and three despite increasing fertilization rates to match tree uptake needs. No additional tree growth benefit in trees planted after WOR has been observed from increased N rates above the standard recommendation. Continued analysis of GHG, soil C levels, and other soil variables will be used to improve predictions of the long-term C storage benefit of WOR.

Session 8: Nutrient Management

Chairs: Nick Clark and Daniel Geisseler

Nitrogen Fertility in Common Beans Following Whole Orchard Recycling

Michelle Leinfelder-Miles, UC Cooperative Extension, San Joaquin County

Mohamed Nouri, Brent Holtz, UC Cooperative Extension, San Joaquin County

Whole Orchard Recycling (WOR) occurs after the productive life of an orchard and is the process of grinding or chipping trees, spreading the wood chips evenly over the soil surface, and then incorporating the biomass into the soil. WOR has become more common in recent years because air quality regulations restrict growers' ability to manage biomass by burning. Meanwhile, researchers have been evaluating its potential benefits for resource management. This is because the practice incorporates large quantities of organic carbon (C) into the soil, and soil C influences soil health, water management, and air quality. Despite potential benefits, incorporating large quantities of C into the soil also has tradeoffs. Woody biomass has a high carbon to nitrogen ratio (C:N), which means that initially, the N is primarily used for microbial energy and maintenance and not available for plant use. This can impact nutrient availability for subsequent crops. Our understanding of nutrient cycling and availability is most advanced in almond WOR sites replanted back to almond. More research is needed to develop N fertility guidelines for annual crops following WOR, and for other recycled trees besides almond. In 2020 and 2021, we established trials to evaluate soil properties and bean yield following walnut WOR. Our objectives were to evaluate soil properties and bean yield following WOR compared to a non-WOR control, and to evaluate two N fertilizer rates. We found that soil organic C and total N were enhanced by WOR. Plant-available nitrate, however, was limited by WOR. This impacted bean yield in the first year after WOR, but doubling the grower's nitrogen rate to just over 200 lb N per acre overcame the first-year yield penalty. In the second year after WOR, neither WOR nor N fertilizer treatments impacted bean yield. To our knowledge, this trial was the first of its kind to evaluate N fertility in an annual crop following WOR. We conclude that soil properties can be enhanced with WOR, and annual crop yield can be maintained with additional N fertilizer in the first year after WOR.

Potentials of Legumes as Food and Cover Crop in California's Cropping Systems

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This presentation summarizes the results of three separate series of experiments to promote fava bean (*Vicia faba* L.) and other legumes in California's agroecosystems.

Firstly, characterizing a panel of diverse fava bean germplasm from USDA-ARS Pullman in different environments of the western United States identified newly developed plant materials that may improve cover crop quality. Specifically, drought tolerance of some fava bean lines compared to the current cover crop standard variety, 'Bell bean,' demonstrates the benefit of selecting materials that better suit dry environments. https://acsess.onlinelibrary.wiley.com/doi/10.1002/agj2.20717s. Also, the diverse seed size of 25 to 330 g per 100 kernel weights offers possibilities of selecting small-seeded fava bean to replace bell bean (450 g per 100 KW) to facilitate seeding. Seed photos and sizes are documented at https://www.favabeanresearch.com/germplasm. The cold hardiness of fava bean and the wide range of flowering span of the plant population offers potentials to provide habitats for pollinators during winter and early spring in California.

Secondly, a demonstration of the potential of fava bean as a vegetable crop for fresh pod production. Five fava bean food varieties were planted in November of 2019 and 2020 and their fresh pods were harvested every two weeks starting from mid-April. In total, 'Vroma' and 'Windsor' produced the largest fresh pod yields (~9 t/ha) over three harvests, Vroma and 'Grano Violetto' yielded more than Windsor, 'Masterpiece,' and 'Aguadulce' in early harvest, while Aguadulce and Windsor produced the highest yield in the last harvest. The nitrogen contribution of these varieties in response to multiple fresh pod harvests demonstrates the benefits of fava bean as both cover and cash crop. A survey found that educating consumers about health benefits and providing food recipes helps promote the consumption of fava bean foods.

Finally, preliminary results from a study addresses barriers to alley cropping in young orchards. In a collaboration with a local grower in Durham, CA, Dax Kimmelshoue, we are studying the effects of growing dry beans (yellow bean and cranberry bean) between young walnuts and almonds. The grower data from 80-120 ac land during 2015-2020 show costs of about \$600 ac^{-1} to grow beans between trees. With an average yield of 2,800 lb bean ac^{-1} over the years, the alley cropping system generated a gross sale of \$1,500 ac^{-1} and a net benefit of \$900 ac^{-1}, which was shared between the grower and orchard owner based on existing agreements. Our 2021 data showed that soil moisture and fruit tree's leaf water potentials were not affected by growing beans between the young orchards. In 2021, winter planted fava bean between orchards produced up to 13,000 lbs fresh pod.ac^{-1} and 2,200 lbs. dry mass ac^{-1}, whereas chickpea produced 215 lbs. dry mass ac^{-1}.

The use of fava bean as a cover crop could be enhanced with selection of more appropriate germplasm for California, plus the crop has great potential to be utilized as a food source in multi-cropping systems.

Onion Response to Irrigation and Nitrogen Rates

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California is the largest onion producer in the nation. Imperial County onion production is about 13,000 acres. Adoption of improved irrigation and nutrient management practices by growers is needed in order to reduce water pollution from excess nutrients in California's low desert region. The main goal of this project is to evaluate the effects of irrigation management and nitrogen fertilization rates on yield and quality of fresh onion bulb production in arid regions. Field assessments were performed in 2019-2020 and 2020-2021 growing seasons at the University of CA Desert Research and Extension Center - UCDREC, Holtville, CA. The assessment was carried out with four replicates in a split-plot design with drip irrigation treatments in the main plot and four N-fertilization rates at the subplot level. Four irrigation levels were established: 40, 70, 100, and 130% of crop evapotranspiration (ETc). Four in-season nitrogen treatments were assessed: 0, 75, 150, and 225 lbs N per acre. Onion yields and bulb size distribution responded to irrigation rates. High value sizes (jumbo, colossal, and super colossal) were highly affected by irrigation rates. Onion size distribution and total yield did not respond to nitrogen rates. There were no significant irrigation rate x nitrogen rate interactions ($P \leq 0.05$) for bulb size distribution and total yield. Jumbo sizes were used for onion quality analysis. There were no statistical differences in measured firmness in response to irrigation and nitrogen rates. Brix values responded to irrigation rates.

SmartLawn Demonstration: Water Budget Calculations for Warm-Season Turfgrass and Turfgrass-Alternative to Meet California's Landscape Ordinance

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1n 1993, California adopted a Model Water Efficient Landscape Ordinance (MWELO), which established an annual maximum applied water allowance (MAWA) and a landscape water budget, calculated by estimating the total water use (ETWU) for the landscape area. To meet MWELO, ETWU (gallons) must be less than MAWA (gallons). To calculate ETWU, a plant factor (PF; percentage of reference evapotranspiration) is required for each plant within the landscaped area. Past work conducted by California horticultural committees representing six regional climate zones established plant factors (PF) for approximately 3,500 plant taxa that are commercially available in the state. For California cool-season turfgrasses, such as Kentucky bluegrass or fine-leaf fescues, the PF is 0.8 or 80% of ETo (Harivandi, et. al. 2009), whereas for warm season turfgrass, such as UC Verde, the PF is 0.6 and for a turf alternative, Kurapia, PF ranges from 0.2 to 0.6 (Harivandi, et. al. 2009; Costello and Jones, 2014; Reid et al. 2015). The SmartLawn demonstration provides irrigation to UC Verde and Kurapia plots by utilizing smart controller technology and either sub-surface or surface irrigation systems. The amount of applied water is measured using an inline flow meter and compared to ETWU and MAWA for MWELO compliance. Data year-to-date indicated that UC Verde could maintain an attractive appearance when provided with roughly half of its expected water usage, the largest reduction observed. Kurapia used less than estimated only when sub-surface irrigated. Future work will focus on adjusting the Kurapia surface irrigated plot to meet MWELO. In addition, we will utilize spectral imaging technology to measure the health of the SmartLawn plots during the growing season.

The Proportion of Bell Bean (fava bean) Biomass and Nitrogen in Cover Crop Mixes in Annual Crops and Orchards in Northern California

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Bell bean (*Vicia faba*) is a major component of cover crop mixes. Depending on the seed mix and cropping system, up to 45% of the cover crop mix seed is bell bean. In this research, we aimed to quantify the proportion of bell bean biomass, nitrogen, and the biological nitrogen fixation (BNF) of bell bean and other legumes in established cover crops in different cropping systems of northern California.

Four fields were sampled: 1) a conventional almond orchard, where the cover crop was grown between the tree rows, 2) a field which is regularly under fiber flax, and 3) a field that is used to grow leafy vegetables. The proportion (by weight) of bell bean seed in seed mixes of field 1-3 was, 27%, 45%, and 22%, respectively. The cover crop biomass from thee 0.1 m2 replications of randomly selected areas within each field were sampled, and separated into the grass, legumes (vetch and pea), and bell bean. Each portion was dried, weighed and ground, and analyzed for total nitrogen (N) and ^{15}N isotopic composition. The results showed that bell bean produced 1,765, 8,267, and 3,321 kg ha^{-1} dry mass in field 1 to 3, respectively. Dry biomass produced from grass totaled 2,000, 8,721, and 11,345 kg ha^{-1}, and pea and vetch together produced 2,164, 14,077, and 14,714 kg ha-1 dry mass.

An additional field of bell bean only cover crop was sampled from an organic rice field, where they grow winter cover crop after the rice harvest. Our results suggest that depending on the growth stage, bell bean fixed a range of 15-76% of its N from the atmosphere.

Photoselective Shade Films Affect Grapevine Berry Secondary Metabolism and Wine Composition

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Runze Yu, Nazareth Torres, S. Kaan Kurtural, University of California, Davis; Mark Battany, University of California Cooperative Extension, San Luis Obispo County

Grapevine physiology and production are challenged by forecasted increases in temperature and water deficits. Within this scenario, photoselective overhead shade films are promising tools in warm viticulture areas to overcome climate change related factors. The aim of this study was to evaluate the vulnerability of 'Cabernet Sauvignon' grape berry to solar radiation overexposure and optimize shade film use for berry development. A randomized complete block design field study was conducted across two years (2020-2021) in Oakville, Napa Valley, CA, with four shade films (D1, D3, D4, D5) differing in the percent of radiation spectra transmitted and compared to an uncovered control (C0). Integrals for gas exchange parameters and mid-day stem water potential were unaffected by the shade films in 2020 and 2021. By harvest, berries from uncovered and shaded vines did not differ in their size or primary metabolism in either year. Despite precipitation exclusion during the dormant season in the shaded treatments, yield did not differ between them and the control in either season. In 2020, total skin anthocyanins (mg/g fresh mass) in the shaded treatments were greater than C0 during berry ripening and at harvest. Conversely, flavonol concentrations in 2020 were reduced in shaded vines compared to C0. The 2020 growing season highlighted the impact of heat degradation on flavonoids. Flavonoid concentrations in 2021 increased until harvest while flavonoid degradation was apparent from veraison to harvest in 2020 across shaded and control vines. Altogether, our results highlighted the need of new approaches in warm viticulture areas given the impact that composition of light has on berry and wine quality.

EM38 Soil Surveys and the collection of site-specific data to build a dataset for 1-D Hydrus modelling to characterize salt transport and estimate leaching fractions for forage fields irrigated with saline drainage water

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Saline waters are increasingly used for irrigation due to a declining supply of good quality irrigation water in California. Saline irrigation brings the risk of salt accumulation in the rootzone, and periodic leaching is required to move accumulated salts below the rootzone. This project aims to gather field-specific data to calibrate Hydrus, a computer model, to simulate 1-dimensional movement of water and salt and predict the outcome of long term, saline irrigation on forage production in the San Joaquin River Improvement Project (SJRIP), a 6,000-acre reuse facility in western Fresno County. Four fields, 70 – 88 acres in size, sown to 'Jose' tall wheatgrass were selected. Salinity of the irrigation water was 4.5 – 9.5 dS/m ECw. The EM38 electromagnetic induction sensor was used to map soil salinity along 20 – 25 transects per field. Twelve ground-truthing locations were then generated per field using the ESAP-RSSD software. Soil samples taken in 30 cm increments to a depth of 120 cm were analyzed for gravimetric

water content, saturation percentage, pH, and ECe. The EM38 sensor data (ECa) was then calibrated to soil salinity (ECe) using the ESAP-Calibrate software. In fields 13-2 and 13-6, salinity was highest in the 30-60 and 60-90 cm soil layers, suggesting a need for increased leaching. The spatial map for field 13-2 revealed very high salinity (>20 dS/m ECe) in a large area in the center north. Field 13-6 had a much smaller area of high salinity (>17.6 dS/m ECe) and larger areas of lower salinity (< 15 dS/m ECe). These spatial patterns of soil salinity will be compared to spatial patterns of forage dry matter yield and satellite imagery (companion poster, M. Soriano et al.).

Potential of Small-Seeded Fava Bean for Cover Crop

Konnor Aiello, California State University, Chico

Kyle Brasier, Hossein Zakeri, California State University, Chico

Legumes, including fava bean (*Vicia faba*) have been increasingly used as a cover crop in agricultural systems due to their ability to biologically fix atmospheric N. However, successful introduction of a new cover crop fava bean variety is dependent on the feasibility to produce seed at a low cost – therefore requiring high seed yield. The purpose of this study will be to gather data on seed yield and agronomic quality of eight fava cultivars over a two-year period. The first variety trial was planted on December 10, 2021 in a randomized complete block design consisting of eight varieties replicated in three blocks for a total of 24 plots. Each 10 x 10 ft plot contained 80 seeds planted into 4-row plots with a row spacing of 2.5 ft and a seed spacing of 10 in. The trial will be rainfed then moved to drip irrigation as needed. Measurements will be taken on total above biomass, below ground biomass and seed yield by weight and number of seeds per pound on a varietal basis. Data will also be collected across multiple developmental stages.

The Effects of Planting Date on Performance of Two Safflower Varieties Grown within Peach Trees in Northern California

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Hossein Zakeri, Kyle G. Braiser, California State University, Chico

Safflower (*Carthamus tinctorius*) cultivation is well established in California. About 30% of the US safflower is produced in California, where the crop also ranks 1st for yield and oil quality. In this study, we tested the feasibility of growing safflower as an intercrop within newly established orchards. Finch and Baldy varieties were planted in November and January of 2020 in a complete randomized block design in three replications. The plots were hand planted and cultural practices such as irrigation and weed control were performed when needed. The Safflowers were hand-harvested and grain yield was recorded. Baldy and Finch varieties reached maturity 6 months after planting (DAP) in November planting treatment and 4 months after planting (DAP) in January, respectively. Averaged over the three replications, the grain yields of both Baldy and Finch plots were 2480 kg/ha (B) and 3300 kg/ha (F) (November planted) and 2800kg/ha (B) and 2670 kg/ha (F) (January planted), respectively. Overall, the November planted Finch variety produced 17% more yield than the January planted Finch and the January planted Baldy variety produced 8% more yield than the November planted Baldy variety. The results suggest that safflower has great potential as an alley crop in young orchards in both winter and spring seasons, and can produce additional income to orchard growers during the early establishment of the young orchards.

Decomposition Rates of Wheat, Fava Bean, and Pea in Northern California

Hope Coulter, California State University, Chico

As California growers are increasingly adopting cover crop (CC) practices. Common CC mixes include plant species from *Poaceae*, *Fabaceae*, and *Brassicaceae*. Seeds of these species are mixed in specific ratios and planted in fall or spring. At termination time the CC is incorporated into the soil or crimped and left on the soil surface. In this study, the decomposition rates of three winter CC species were quantified to help growers choose which CC species to incorporate into their mix, timing of CC termination, and planting date of subsequent crops.

Roots and aboveground biomass (AGB) of winter-grown wheat, faba bean, and pea were harvested in the spring at the legumes' full-pod stage. The root biomass was washed, and both root and AGB were cut into pieces ~1 cm long. 40g fresh biomass each of the root and AGB were weighed into semipermeable bags and secured with zip ties. Depending on the quantity of material available, 21-28 samples of each species were prepared. One bag of each set was dried to get the initial moisture content. The remaining bags were buried ~1ft deep between rows of established calendula flowers. Bags were removed from the field every 7-24 days, dried and weighed. Decomposition was measured in % /week of biomass lost.

Averaged over two years, the decomposition rate of wheat root and AGB was 2.6 and 4.0%/week respectively. For pea root and AGB these values were 3.3 and 3.2%/week respectively, and for faba bean root and AGB they were 3.5 and 3.0%/week respectively. The decomposition rate of all roots taken together was 3.1%/week and the decomposition rate of all AGB taken together was 3.4%/week.

Salinity Tolerance and Forage Quality Comparison for Four Varieties of Alfalfa (*Medicago Sativa*)

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Harmanpreet Sharma, John T. Bushoven, Sharon Benes and Ranjit Riar; California State University, Fresno

Alfalfa is an important forage and the most valued hay crop for California's dairy industry which leads the nation in milk production. Statewide, alfalfa was grown on 515,000 acres in 2020 (USDA-NASS, 2020), down from over a million acres in 2006. California alfalfa yields average 7.1 tons/acre, nearly twice the U.S average, due to a long growing season that allows for more cuts per year and to breeding efforts to address changing conditions in climate, water availability and soil quality (Geisseler and Horwath, 2016). With increasing drought and irrigation water scarcity, lower quality irrigation waters that are often saline are increasingly used for forage irrigation, as our marginal soils, higher in salinity. Alfalfa seed companies have foreseen this trend and invested considerable resources into breeding more salt tolerant varieties (Alforex, https://www.alforexseeds.com/alforex-alfalfa-seed-technology/hi-salt-salinity-tolerant-alfalfa-seed/). In this experiment, four alfalfa (*Medicago sativa*) cultivars are being evaluated at five irrigation water salinity levels (0.5, 5, 10, 15, 20 ds/m ECw) using a split plot design in an outdoor pot experiment. A companion seed germination test is also being conducted. The cultivars include two newly licensed varieties from Barkley Seed, Inc. (B6604-0588F, B6269 SR), a salt tolerant control (AZ90NDCST) and a public control (CUF101). The seedlings were established under non-saline conditions and grown in large pots (15 gal.) filled with a 4:1 fritted clay to peat moss combination. Nutrient solution (1/4 strength Hoagland's) was applied every two weeks. Once salinization began, the plants were cut to the crown and then harvested every 3 to 4 weeks, just prior to flowering in the controls. Dry matter production and sodium and potassium accumulation in shoot tissue will be presented.

Developing Strategies to Terminate Winter-Grown Nitrogen Scavenger Cover Crops in Central California

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New California agriculture regulation offers nitrogen (N) credit to Central California growers who grow N scavenger winter cover crops. The regulation has three requirements: 1) cover crop must grow at least 90 days during October to April, 2) cover crop must produce at least 4500 lbs. dry biomass/ acre, and 3) cover crop shoot biomass has a carbon: nitrogen (C: N) ratio of at least 20:1. From these requirements, the last two cannot be quantified in the field. This project aims to identify plant traits related to dry mass and C: N ratio of oat (*Avena sativa*) at different developmental stages to provide guidance to growers for terminating oat cover crop to receive N credit. The experiment consists of pot and field studies.

In the pot study, Cayuse oat was sown in ½ gallon pots that contained potting mix soil and 1g of Vigoro Flowering Plant Food (NPK: 15-30-15). Pots were arranged in a completely randomized design (CRD with three top-dress N treatments of 2.5 g N /pot at tillering and 2.5 g pot^{-1} at stem elongation, and non-treated control. The experiment has three replications. Leaf chlorophyll content has been estimated with a SPAD Chlorophyll meter, and plant height has been recorded weekly. The oat plants will be terminated at five different growing stages of 1) tillering, 2) stem elongation, 3) boot, 4) heading, and 5) physiological maturity. At termination, plant dry matter will be measured, and plants will be dried, grinded and their N and C content will be measured with the combustion method. Similar measurements have been carried out on Cayuse oat in the field.

Competitive effects of glyphosate-resistant and -susceptible Palmer amaranth plants with grapevines during vineyard establishment

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Palmer amaranth has been ranked as one of the worst weeds in US agriculture. This species has evolved resistance to several herbicides including glyphosate. Glyphosate-resistant (GR) populations of Palmer amaranth have also been documented in California. Glyphosate is also a common herbicide in perennial cropping systems in California. In recent years, the prevalence of this species has also been noticed in vineyards. However, it is not known if these are GR or glyphosate-susceptible types. Furthermore, it is not known if these two types are different in their competitive ability in vineyards, especially newly established vines, or if the GR type has an associated fitness penalty. Therefore, a study was conducted in 2020 and 2021 to assess the difference in the competitive ability of GR and GS Palmer amaranth with young grapevines and to compare the growth and biomass of GR and GS Palmer amaranth biotypes in a wine grape vineyard in Fresno, CA. Young Grenache 1A on Freedom Uber vines was transplanted on May 12, 2020 and March 19, 2021 in two vine rows spaced 11 ft and 6 ft apart within a row. GR and GS palmer amaranth seedlings were planted about 6 in close to some of the vines or by themselves alone. There were five treatments that included grape alone, grape + one GR palmer, grape + one GS palmer, GR palmer alone, and GS palmer alone. Each treatment was replicated five times and arranged in a randomized complete block design. GR and GS Palmer amaranth seedlings of similar height and size were chosen for transplanting. The plants were allowed to grow till August 27 in 2020 and July 19 in 2021. They were then harvested. The length of the mainstem of the grape plants was recorded and the leaves were separated from the stems. The weight of the stems and leaves were taken after drying them in a forced-air over at 60°C for 96 hours. Similarly, each palmer amaranth plant was also harvested, and the dry weight of the aboveground parts was recorded. Data on the mainstem length and dry weights were subjected to ANOVA and means were separated by Fisher's LST test when significant at a 0.05 level of significance. There were no interactions between year and treatment for any of the variables, therefore the data for the two years was combined. In comparison to grape-alone, the mainstem length and total grape biomass was reduced by 30% and 43%, respectively by the GR plants but the GS palmer amaranth had no effect. However, the GR and GS palmer amaranth alone had similar dry biomass. Therefore, this study showed that the GR palmer amaranth plants were more competitive than the GS plants with young grapevines and showed no fitness penalty despite being glyphosate resistance.

Virulence of fungicide-resistant *Botrytis cinerea* isolates on detached grapes, peppers, blueberries, and tomatoes treated and untreated with boscalid and fluopyram

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Margaret Ellis and Dave Goorahoo, Department of Plant Sciences, California State University, Fresno; Rachel Naegele, USDA ARS SJVASSC

Botrytis cinerea is the causal agent of both pre- and post-harvest diseases that commonly affects grapes, strawberries, peppers, tomato, and blueberry. Because of its rapid reproduction cycle and genetic diversity, *B. cinerea* is a high-risk pathogen for fungicide resistance development. Fungicide resistance is an increasingly common problem in California specialty crops and resistance monitoring programs are essential to protect the efficacious use of currently available fungicides. Little research has been published on the virulence of fungicide resistant *B. cinerea* isolates assayed on different hosts, and therefore was the objective of this study. Single spore isolates collected from strawberry, grape, and blueberry previously identified as resistant or susceptible to boscalid and fluopyram were used to inoculate detached grapes, mini-peppers, cherry tomatoes, and blueberries with and without the presence of the fungicides. Lesion width and disease severity was recorded twice per assay. There were significant differences ($P<0.05$) for host, isolate, and fungicide and their interactions for disease severity, disease incidence, and lesion width. Results from this study indicated significant differences for certain *B. cinerea* isolates among the hosts tested and that some fungicide resistant isolates may have an unknown fitness advantage or disadvantage depending on the host plant. However, no consistent significant differences in virulence were observed for boscalid or fluopyram-resistant *Botrytis cinerea* isolates with or without the presence of fungicides compared to the control treatment.

Water Use Efficiency in Olives Super High Density (SHD)

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Cultivation of olives has rapidly increased in California in recent decades because of increased demands for olive oil and olive-based products. California is now a large olive producer in the country and in the world. However, precise information on olive water use and response to water stress is not available for growers in CA. Environmental and regulatory limitations are forcing CA growers to adopt alternative more efficient irrigation managements such as deficit irrigation to reduce the amount of water used for unit of oil production. This project aimed to characterize olive water use and the effects of deficit irrigation on olive oil yield and quality. A 5-7-Year-old super high-density olive orchard (cv Arbequina) in Corning CA was selected for the experiment. An ET station was installed to measure Evapotranspiration using the Eddy covariance method. Experimental design was randomized block design with three treatments and four replications per treatment. The treatments were: control (grower practices), 20% reduction of water application during pit hardening and 75% of reduction during pit hardening. Midday stem water potential was measured weekly and shoot growth biweekly on three trees per replication. Baseline measurements were taken from March to May. Deficit irrigation was applied from July to September.

Impacts of soil health focused nutrient management strategies on crop nitrogen uptake and nitrous oxide emissions in leafy green agroecosystems

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Production of leafy greens requires high inputs, frequent cultivation, and intensive overhead and/or surface irrigation. These extensive management requirements make achieving soil health improvements a challenge. Enhancing soil health in lettuce production has many potential co-benefits, such as increasing soil organic nitrogen (N) availability, reducing fertilizer N input, and improving crop and fertilizer N use efficiency, and reducing the greenhouse gas, nitrous oxide (N_2O). In partnership with a large-scale commercial producer in Salinas, CA, we implemented a split-plot designed field experiment with treatments receiving N applications at grower's standard (GS) rate (290 lbs N ac^{-1}), NRCS Nutrient Management Conservation Practice Standard (CPS) 590 rate (232 lbs N ac^{-1}), and no N (control). In split fertilizer plots, compost was applied at a rate of 5 d.w.t/acre and a no compost plot. Soil, crop, and greenhouse gas data were collected over a period of 12 months. Results show that crop N uptake was only significantly different ($p=0.03$) between the GS rate and the no N treatments, while no difference was found between GS and CPS N rates. Regardless of N application rates, the addition of compost did not significantly increase crop N uptake. Cumulative N_2O emissions were highest in the GS treatment (36.3 mg N_2O-N m^{-2}) and lowest in the No N with compost treatment (9.9 mg N_2O-N m^{-2}). All the treatments that received compost had lower N_2O emissions compared to those without compost (N application alone). Our work will continue for another two years, with broccoli included in crop rotations.

Water Use Efficiency (WUE) and Drought Tolerance Traits of Fava Bean in Relation to the Plant ^{13}C Isotope Composition

Erik Spitzer, California State University, Chico

Faba bean (*Vicia faba*) is grown in winter cover crop mixes in California. In this study, we compared agronomic performance and physiological traits related to WUE and drought tolerance of several fava bean lines in the field and a pot study. A panel of 63 fava bean lines was evaluated for their ^{13}C composition in four environments. Seven lines with extreme ^{13}C values were selected and studied for their drought tolerance and WUE traits under full-irrigation and drought treatments in a pot study. The fava bean lines produced a range of 16.8 to 28.7 g $plant^{-1}$ grain, and 34.9 to 55.8 g plant $^{-1}$ dry biomass (with grain) in the drought treatment group. Lines in the fully-watered condition produced a range of 18.4 to 49.8 $plant^{-1}$ grain, and 50.2 to 72.7 g plant $^{-1}$ dry biomass (with grain). On average, fully watered plants transpired a range of 19.3 to 29.0 L water plant-1 and stressed plants had a range of 7.4 to 15.8 L $plant^{-1}$ transpiration during the growing season, as measured by the cumulative daily loss of soil moisture weight over time. The WUE_{grain} of the faba bean lines ranged from 0.179 to 0.350 gL^{-1} in fully-watered conditions, and 0.207 to 0.304 gL^{-1} in drought stressed conditions.

In a second experiment, the performance of 7 faba bean lines with high WUE were selected for testing in a field study comprised of 4 replications under rainfed and additional irrigation. From these lines, Ziyad Brothers Import and V4-Derived produced the highest grain yield under irrigation and non-irrigation, respectively. PF17339-342 had the lowest grain yield reduction in response drought conditions. Boccli displayed the most drought stress resilience as measured by physiological metrics (leaf temperature, photosynthetic gas exchange). Faba bean δ13C was moderately correlated with leaf temperature and $WUE_{biomass}$. (R^2 = .5501, R^2 = .4271 respectively).

The Effects of Termination Time on Fava Biomass and Nitrogen Contribution to the Soil

Amelia Zepeda, California State University, Chico

A field trial was established at the USDA Natural Resources Conservation Service Plant Materials Center (PMC) at Lockeford, CA. Two fava bean varieties (bell bean and windsor) were planted in two side-by-side randomized complete block with four replications in November of 2019 and 2020. Four termination times (treatments) were randomized within each experiment. The fava bean varieties were sampled from corresponding plots based on its life cycle (flowering, first pod, full-pod, and maturity stages). After sampling, the plot was terminated with a mower and fava residues were left on the surface. The fava bean variety samples were dried, weighed, ground, and analyzed for N and ^{15}N compositions. After the last sampling, sudangrass (*Sorghum X drummondii*) was planted in the same field. Sudangrass was sampled when it was roughly 2ft tall in the summer of 2020, and dried, weighed, ground, and analyzed for N in a Leco CN analyzer. In 2021, sundangrass was sampled at the same stage as year one (2019), mowed and a 2nd sample was taken after a regrowth and when the grass was about 2 ft tall.

In 2019 (year one), averaged over four replications, bell bean accumulated 274, 1007, 1725 and, 4713 kg ac-1 and fixed 33, 57, 44, and 45% of its N from the atmosphere (%Ndfa) at flowering, first-pod, full-pod and maturity, respectively. In the same year, windsor accumulated 817, 2554, 3658 and 5738 kg ac-1 and fixed 33, 57, 44, and 45% of its N from the atmosphere at flowering, first-pod, full-pod and maturity, respectively. In this year, total N benefits of bell bean were 4, 14, 21, and 52 kg N/ac-1 and the total N benefits of windsor was 11, 39, 45, and 66 kg N ac-1 at flowering, first-pod, full-pod and maturity, respectively. Averaged over two varieties, sundangrass accumulated 3597, 3252, 6619 and 4471 kg/ha-1 dry mass and windsor 3949, 3427, 6568, and 5915 kg N ac -1. The sundangrass N content from the bell bean plots were 23, 23, 41 and 36 kg/ha-1. The sudangrass from the Windsor plots had an N content of 36,38,52,51kg/ha-1 from plots that were terminated at flowering, first-pod, full-pod and maturity, respectively. The results suggest that the fava bean %Ndfa increased after the first sampling date but remained similar across the other three sampling dates. The total N from fixation (biomass x %N x %Ndfa) increased throughout the season and maximized at the last sampling date. Two fava bean varieties had a similar pattern in %Ndfa, and total N from fixation throughout the season and maximized at the last sampling. Sundangrass biomass production in response to the fava bean termination times was inconsistent. However, it seems that terminating the fava bean after the full-pod stage increased biomass production of the sundangrass. Higher biomass production of sundangrass in the late-terminated fava bean plots could be associated with more available nitrogen from the fava bean found in the soil. Lower sundangrass biomass could be associated with the N in the fava bean plants being held up within the plant and not having the time to break down to be usable within the soil for the sudangrass.

Cover Crops and Tillage Effects on Grapevine Physiology and Metabolism in a Mature Vineyard in San Joaquin Valley

Maria Zumkeller, University of California, Davis

Kaan Kurtural, University of California, Davis; Runze Yu, California State University, Fresno; Nazareth Torres, Universidad Pública de Navarra

The San Joaquin Valley is one of the leading irrigated viticulture regions in the world. However, decreases in precipitation amounts and increases in temperature threaten soil water content. Although cover crops are promising resources to face this water scarcity, given that they mitigate soil erosion and water loss, there is a lack of information on how they work under different tillage systems. The aim of this study was to find the best management of vineyard soils using different cover crop and tillage systems to preserve plant available water in soil prior to the initiation of irrigation. A randomized study was conducted in Fresno with three cover crops, a permanent grass, barley, and native vegetation, under till vs. no-till systems in a Ruby Cabernet (*Vitis vinifera* spp.) vineyard. Our results indicated that grass under no-till preserved plant available water, which resulted in 30% less negative mid-day stem water potential in grapevine. Consequently, net carbon assimilation of grapevines grown with grass as cover crop under no-till management was enhanced compared to those with barley and natural vegetation. On the other hand, no-till associated with barley diminished carbon assimilation during berry ripening that led to lower content of sucrose in shoots. At harvest, no changes on berry mass, must pH, acidity or total soluble solids were recorded. Similarly, neither yield per vine nor berry flavonoids responded to different cover crops or tilling systems. Therefore, the use of cover crops under no-till systems may be implemented in irrigated vineyards of San Joaquin Valley with no effect on grape productivity but improving grapevine water use. These findings provide new insights into the dynamics of soil-grapevine-atmosphere continuum under current warmer conditions.

APPENDICES

California Chapter Presidents

YEAR	PRESIDENT	YEAR	PRESIDENT
1972	Duane S. Mikkelsen	2001	Steve Kaffka
1973	Iver Johnson	2002	Dave Zodolske
1974	Parker E. Pratt	2003	Casey Walsh Cady
1975	Malcolm H. McVickar	2004	Ronald Brase
1975	Oscar E. Lorenz	2005	Bruce Roberts
1976	Donald L. Smith	2006	Will Horwath
1977	R. Merton Love	2007	Ben Nydam
1978	Stephen T. Cockerham	2008	Tom Babb
1979	Roy L. Bronson	2009	Joe Fabry
1980	George R. Hawkes	2010	Larry Schwankl
1981	Harry P. Karle	2011	Mary Bianchi
1982	Carl Spiva	2012	Allan Fulton
1983	Kent Tyler	2013	Dave Goorahoo
1984	Dick Thorup	2014	Steve Grattan
1985	Burl Meek	2015	Richard Smith
1986	G. Stuart Pettygrove	2016	Bob Hutmacher
1987	William L. Hagan	2017	Sharon Benes
1988	Gaylord P. Patten	2018	Daniel Munk
1989	Nat B. Dellavalle	2020	Karen Lowell
1990	Carol Frate	2021	Eric Ellison
1991	Dennis J. Larson		
1992	Roland D. Meyer		
1993	Albert E. Ludwick		
1994	Brock Taylor		
1995	Jim Oster		
1996	Dennis Westcot		
1997	Terry Smith		
1998	Shannon Mueller		
1999	D. William Rains		
2000	Robert Dixon		

2022 Business Meeting Agenda

California Chapter of the American Society of Agronomy
February 2, 2022, 1:00 PM

1. **Call to Order** (Florence Cassel, President, California Chapter ASA)

2. **Approval of attached business meeting minutes from the 2021 CA-ASA Plant and Soil Conference** (F. Cassel)

3. **Financial Report** (M. Cady)

4. **Action Item: Announcement of new Executive Committee Member and Nominations of new Governing Board Members for membership vote (**F. Cassel)
    a. Completion of third-year term: Jacob Wenger, Nick Clark, and Michael Cahn
    b. Nick Clark to serve on the Executive Committee
    c. Nominations of new persons to serve on the Council of Representatives
        i. Ian Grettenberger, UC Davis
        ii. Hossein Zakeri, Associate Professor, CSU Chico
        iii. Sultan Begna, Research Agronomist, USDA-Agricultural Research Service

5. **Announcement of Student Scholarship Award (WPHA)** (Jacob Wenger, Chair of student scholarship committee)

6. **Announcement of Student Lightning Presentation Awards** (Nick Clark, Chair of student lightning presentation committee)

7. **Presentation of Awards to 2022 Honorees** (Eric Ellison)
    a. Blake Sanden (presented by Bob Beede)
    b. Bruce Roberts (presented by Phillip Smith)

8. **Additional discussion as requested by the membership**

9. **Passing of the CA-ASA Gavel to Incoming President** (F. Cassel to Michelle Leinfelder-Miles)

10. **Thanking of Outgoing President** (M. Leinfelder-Miles)

11. **Business meeting adjourned** (M. Leinfelder-Miles)

Persons nominated by the Executive Committee to serve on the Governing Board

Ian Grettenberger is an Assistant Specialist in Cooperative Extension at University of California Davis in the Department of Entomology and Nematology. He holds a PhD from Pennsylvania State University. He focuses on research and extension for field and vegetable crop entomology across California. His research aims to develop IPM tactics that provide tools and solutions for growers and pest managers. Currently, he works across a variety of crops, including cotton, rice, alfalfa, cole crops, lettuce, melons, and tomatoes. This work includes research on invasive species, pest monitoring, biological control, insecticide resistance, and evaluation of insecticide tools and programs.

Hossein Zakeri is an Associate Professor in the College of Agriculture at California State University, Chico. He received his Ph.D. in the field of crop physiology and cropping systems from the University of Saskatchewan in Canada. His work focuses on row crops, including safflower, wheat, lentil, pea, canola and soybean. His research program emphasizes on cropping systems diversity, plant nutrition, biological nitrogen fixation, plant response to heat and drought stresses, and the economic and environmental benefits of legume crops. At CSU Chico, he teaches courses on introduction to plant sciences, crop physiology, production of annual crops, and agricultural research.

Sultan Begna is a research agronomist at USDA-ARS's San Joaquin Valley Agricultural Science Center in Parlier, California. He earned his M.S. in agronomy and Ph.D. in plant science (agronomy& crop physiology focused) from McGill University in Montreal, Canada. He has worked on diverse grain and forage crops in relation to biotic and abiotic factors for many years (as post-doc research associate with USDA-ARS and Montana State University and research scientist with New Mexico State University). His current research program involves alfalfa aimed at improving alfalfa production and water use efficiency in California.

2021 Business Meeting Minutes

California Chapter of the American Society of Agronomy

Date: Wednesday, February 2nd, 2021
Location: Virtual via Zoom
Presider: Eric Ellison, CA ASA President

1) **Meeting called to order with welcoming remarks at 1:00 pm.**
   Announcements and words of thanks expressed by Eric Ellison. A special thanks to UC ANR Program Support Unit and the sponsors of this year's conference, which included Western Plant Health Association, Mid Valley Agricultural Services Valley Tech Agricultural Laboratories and Dellavalle Laboratories.

2) **Motion carried to approve minutes from 2020 Business Meeting. Minutes were approved.**

3) **Financial Report**
   The balance after the 2020 conference was about $32,800. The balance may increase with this year's conference, as the number of paying attendees exceeded our expectations and the registration fee was set to break even.

4) **Nominations for board members:**
   - Governing Board: Marja Koivunen (Vestaron Corp.), Sarah Light (University of California Cooperative Extension, Sutter & Yuba counties), and Ranjit Riar (California State University, Fresno).
   - Executive Board: Mark Cady (CDFA- FREP).

   Motion carried to approve nominees. All nominees were approved.

5) **Scholarship Award**
   Jacob Wenger presented Scholarship Award to Mario Lemus (CSU Fresno).
   The award was sponsored by the Western Plant Health Association.

6) **Lightning Presentation Awards**
   Eleven students presented their research.
   Nick Clark announced the Lightning Presentation Award winners:
   - 1st place: Jessica Kanter, UC Davis
   - 2nd place: Suzette Turner, UC Davis
   - 3rd place: Ramandeep Brar, CSU Fresno
   - 4th place: Simarjeet Singh, CSU Fresno
   - 5th place: Jasmin Ramirez, UC Davis

7) **Additional discussion as requested by the membership**
   No discussion was requested

8) **Eric Ellison passed the gavel to the incoming president, Florence Cassel.**

9) **Thanking of Outgoing President**

10) **Motion carried to adjourn. Meeting adjourned at 1:45 pm.**

On Monday, February 1st, 2021, the chapter honored the following individuals for their dedicated careers to the fields of agronomy, crop science, and soil science:

- Marsha Campbell, University of California Cooperative Extension Farm Advisor, Stanislaus County.
- Keith Backman, Pomologist, Certified Crop Advisor, Dellavalle Laboratory.

Index of Primary Authors/Presenters

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2022 Plant and Soil Conference

THANK YOU FOR ATTENDING!