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News from the Subtropical Tree Crop Farm Advisors in California

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The Role of Pollinators in Avocado Production: Insights from Recent Research

Hamutahl Cohen, Entomology Advisor, UCCE
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Ben Faber, Subtropical Crops Advisor, UCCE

Avocado pollination is a little-understood process influenced by flower biology, environmental conditions, and pollinator behavior. Our study from UC Cooperative Extension and UC Davis aims to shed light on the complexity of avocado pollination and the role of various insect species in enhancing fruit set. Understanding these dynamics can help growers improve yields and optimize orchard management.

Understanding Avocado Pollination

Avocado flowers exhibit a unique pollination process known as dichogamy, where each flower transitions from a female phase (stigma receptive) to a male phase (pollen release). This transition occurs at regular intervals and depends on the cultivar type (Type A or Type B). While self-pollination can occur during brief self-overlap periods, cross-pollination—when pollen is transferred between different cultivars—has been found to enhance fruit production.

Factors influencing cross-pollination include the proximity of pollenizer trees, the timing of male and female bloom phases, and the presence of active pollinators. Weather conditions and site management practices further shape the pollination landscape.

Key Pollinators of Avocado Trees

Multiple insect species might contribute to avocado pollination, including bees, wasps, flies, beetles, and thrips. Each group varies in its efficiency and frequency of avocado flower visitation.

Bees: The Primary Pollinators

Bees, particularly honey bees (*Apis mellifera*), play a crucial role in avocado pollination. Honey bees increase pollination rates, but the majority of honey bees visit a limited area of 1-3 trees, performing cross pollination between cross-cultivars located within two rows. Only a small percentage of forager bees, called "scout" bees, have longer foraging distances and are capable of transferring pollen over hundreds of meters. While increasing honey bee density increases pollination rates, studies have repeatedly shown since the 1960s that honey bees prefer non-crop flowers over avocado blooms, likely due to the chemical composition of avocado nectar which is high in potassium and phosphorus.

Bumble bees (*Bombus occidentalis*) have been minimally evaluated in California for their pollination potential, but have been observed foraging in Hass and enhancing yield in trees within three rows of managed colonies. Additionally, wild bees, including species like *Ceratina acantha*, *Agapostemon texanus* and *Halictus tripartitus*, contribute to pollination, particularly in orchards with diverse floral resources and nearby wild habitat for nesting.

Other Insect Pollinators

- **Wasps**: Seven species, primarily from the Crabonidae and Vespidae families, have been recorded visiting avocado flowers.
- **Flies**: More than 20 fly species, including syrphid flies (hoverflies), have been observed visiting avocado flowers. Some flies, such as blow flies, have been observed depositing avocado pollen. These insects tend to move randomly, which can facilitate cross pollination.
- **Other Insects**: Beetles, thrips, and moths may also contribute to pollination, though their effectiveness remains uncertain.

The Impact of Habitat and Management Practices

Our main research goals are to identify the species of pollinators visiting avocado in Ventura and ask how they are influenced by farm management, habitat, and weather. We are tracking avocado visitors in 10 avocado ranches in Ventura by using visual surveys and netting at individual trees which we track from bloom to fruit set. Preliminary findings suggest that increasing the presence of non-crop flowers can impact pollinator behavior and fruit set.

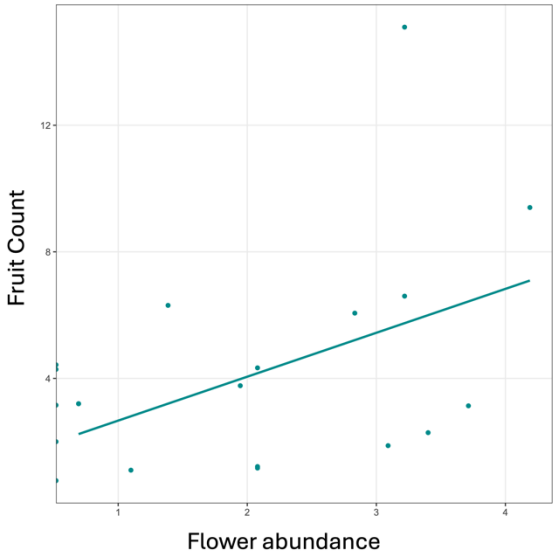

Figure 1. The number of non-crop flowers (represented on a log scale) is associated with higher avocado fruit count in orchards, regardless of whether the flowers are intentionally planted hedgerows or from weedy species.

- **Flowers matter:** Avocado trees surrounded by higher counts of non-crop flowers, either from intentionally-planted hedgerows or weedy flowers, have more honey bees visiting their flowers. These trees subsequently had higher fruit counts when we assessed fruit set (Fig. 1).
- **Landscape-scale habitat**: Orchards near natural, non-crop habitats have a higher diversity of wild pollinators in the orchard flying around, but we aren't sure yet if this means higher crop visitation and pollination.
- **Weather conditions**: Warmer temperatures correlate with increased pollinator activity, but we want to know if temperature variability throughout an individual orchard also influence the response of pollinators.

Next Steps

We are still working on learning more about avocado pollination, specifically by identifying and analyzing collected pollinators to see who are the key players besides honey bees. We are also designing experiments to measure pollination efficiency of different insect species and collecting detailed weather data to assess its impact on pollination dynamics. We'll keep you tuned in for updates here at Topics at Subtropics as we learn more.

Is that a Fruit Fly?

Bodil Cass, Department of Entomology, UC Riverside

I was in a citrus orchard in San Diego recently with some colleagues, looking for sap-sucking hemipterans to run an experiment. I kept getting distracted, however, by some small flies. They were shiny, bright yellow with black stripes, like a miniature, polished hoverfly. Every tree I inspected in this corner of the orchard had a dozen or so of these little flies flitting about (Figure 1). My team was calling me on to move to the next part of the survey, so I grabbed my aspirator from the truck and sucked some up for a closer look back at the lab.

Flies (Diptera, the 'two-winged' true flies, which have their hindwings reduced into halteres for balance during flight) are everywhere, being among the most common and specious type of animal globally. They fill every ecological role from decomposer to pollinator and herbivore to predator, and include the biting mosquitoes and tsetse flies. Their success is partly attributed to their holometabolous life cycle, which allow the immature larvae ('maggots') to focus on feeding and growing, often obscured in a mushy or liquid substrate, and the winged adults to focus on dispersal and reproduction, which they do very well, being among the most apt and agile animals in the air.

A swarm of flies in a citrus grove isn't necessarily noteworthy, given the ubiquity of their taxonomic order. Unless, they're an invasive species not established here, especially any of the species that feed on ripening fruit and render the produce unmarketable. The flies in question were slightly larger than a vinegar fly like *Drosophila* spp. and smaller than a true Tephritid fruit fly. In Southern California I might expect to occasionally run into Spotted Wing Drosophila (Cherry Vinegar Fly, *Drosophila suzukii*, whose maggots feed on fresh berries (Caprile et al. 2011). I might also catch a cloud of Mexfly (*Anastrapha ludens*) or Medfly (*Ceratitis capitata*) from one of the sterile insect technique release programs that drop millions of irradiated flies from aircraft to suppress and eradicate any breeding populations of invasive Tephritids (CDFA, n.d.; "Fruit Flies" 03/2025). Under the microscope mystery flies were not a visual match for either of these known pest species, based on their distinctive markings and size. My mind still abuzz from one of the worst true fruit fly years on record (Sequeira and Bond

Figure 1. Four of the mystery flies seen on leaves of tree in a citrus grove in San Diego County. They were determined to be *Thaumatomyia* sp. (Diptera: Chloropidae), a common grass fly that is a predator of root aphids and not a pest of citrus. Some red armored scale insects are also visible on the leaf. Credit: Bodil Cass.

2024), it was still important to identify them, to rule out any other new introduction incompatible with fruit farming.

Figure 2. *Thaumatomyia* spp. (Diptera: Chloropidae) side view (a) and top view (b) showing the distinctive yellow scutellum and black stripes. Some setae (small hairs) and wing veins are visible, along with the halteres (reduced second pair of wings) and occelii (small simple eyes between the larger compound eyes). Credit: Bodil Cass.

The mystery flies in this case were an innocuous **frit or grass flies** (Chloropidae). Based on their morphology under the microscope (Figure 2), these were likely the cosmopolitan species *Thaumatomyia glabra,* which is unusual in the chloropid group because their larvae are predators of root aphids (Sabrosky 1935). This species has only minute morphological differences to *Chlorops* spp., another common chloropid that is a stem borer of grasses (Sabrosky 1943). Neither are a concern for citrus growers. They were likely coming from the diverse flora in the adjacent riparian area. Most chlorops are detritivores in decaying vegetation, but the family also includes some agricultural pests of turf and grain production (Sutherland et al. n.d.) and includes the eye gnats, which are mechanical vectors of some animal pathogens such as the causative agent of conjunctivitis (pinkeye; Bethke, Vander Mey, and Bates 2013). I was delighted to learn that some less common species in the chlorops family utilize diverse food sources including dung and bird nest debris. The larvae of one Australian genus reportedly develop as a parasite under the skin of frogs and toads (Hoskin and McCallum 2007).

Figure 3. A chloropid frit fly visiting an avocado flower for nectar in Ventura County. Credit: Hamutahl Cohen.

In this case, the yellow and black stripes were not a warning sign but a beneficial predator common in the local ecosystem. My colleagues report seeing them visiting avocado flowers for nectar in Ventura County (Figure 3). A delightful find, that I'm glad I took the time to notice and read about. If you find an insect that needs identifying, please contact your local UCCE office or the CDFA Pest Hotline (1-800-491-1899; https://www.cdfa.ca.gov/plant/reportapest/).

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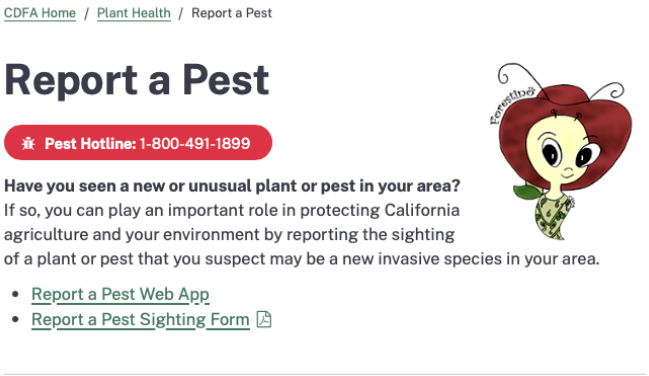

Please report potential pests to UCCE or the **CDFA Pest Hotline 1-800-491-1899** **https://www.cdfa.ca.gov/plant/reportapest/**

Sivanto Labelled for Control of Pink Hibiscus Mealybug in Dates

Bodil Cass & Tom Perring, Department of Entomology, UC Riverside

The registration label for Sivano use against Pink Hibiscus Mealybug (*Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae)) was approved by DPR last year. The label can be found at the following link, with dates listed on page 18:

https://s3-us-west-1.amazonaws.com/agrian-cg-fs1-production/pdfs/Sivanto_prime_Label1fd.pdf

This material that works on pink hibiscus mealybug and other sucking insects (not mites) that feed on dates. A suggested use strategy is to flag any palms that have any mealybug-infested bunches at harvest, and treat the crowns of those palms after the winter clean up. This should kill any residual mealybugs that may have found their way to the crown after harvest. There is no need to treat prophylactically, as we are not able to predict where the infested bunches might occur.

Pink hibiscus mealybug was detected in Imperial Valley in 1999 and successfully controlled through a biological control program with two parasitoid wasps (Roltsch et.al. 2006). It was later detected further north in the Coachella Valley, where a biological control program using parasitoid wasps has been effective for residential plants. Commercial production requires an integrated management program, as the efficacy of parasitoids can be reduced by other cultural practices like bagging that are necessary for fruit development and protection from other pests and pathogens, that can cause the mealybugs to build up quickly in a short time (Ganjisaffar et.al. 2019). The registration of Sivanto provides growers with additional tools for different stages of the growing season.

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Consperse Stink Bug

Ben Faber, Subtropical Crops Advisor, UCCE

In the last month there have been sightings of a stink bug on avocado fruit and stems in the Santa Paula/Fillmore area. The bug feeds on the stems of mature fruit, causing damage to the stem, creating wounds that leak white sugar exudate on the stem that drips on to the fruit. The weakened stem can't hold the fruit, and it drops. The stink bug can also feed directly on tender young fruit.

We last had an outbreak in 2014 of Bagrada bug, another species of stink bug. The current outbreak was a different species that we first identified as Brown Marmorated Stink Bug (BMSB). We sent samples off to Dr. Jhalendra Rijal, a UCCE nut advisor in the Central Valley who has done a lot of work on stink bugs. The identification came back as *Euschistus conspersus,* Consperse stink bug. The following is some of the dialogue Dr. Rijal shared with us:

"Different species of stink bugs all have similar life histories. They overwinter as adults under leaves and trash, in the crowns of plants, and in clumps of grass on the orchard floor. They also may be found outside the orchard in the crowns of plants such as blackberry or in other protected places such as box piles and buildings. After mating, if suitable host plants are not present in the orchard, adults move out of the orchard to suitable host plants. Most of the species remain on weeds and ground cover plants at this time, but when the hillsides dry up, they look for green, well-watered hosts like avocados. Outbreaks tend to be cyclical. What the cycle is, is not clear.

"Adults have shield-shaped bodies that are about 0.5 inch long and either brown or green with red, pink, or yellow markings. Barrel-shaped eggs are laid in clusters of about 14 on leaves of broadleaf plants. Eggs are pearly white when first laid, later turning cream colored or pinkish just before hatching. For consperse stink bugs, a row of spines encircle the top of the eggs; the other species have concentric black rings on top of the eggs. Early nymphal stages have various markings and patterns and no wings but resemble adults in shape. Nymphs develop prominent wing pads in the fourth and fifth instars.
"Consperse can be found in any orchard and field crops system (pretty much), but the problem happens when their numbers get so high. I mean, collecting over 10 Consperse by hand indicates a pretty high

population. So, something different is going on in the area. (*The grower had collected 14 stink bugs to send to Jhalendra, so he's saying there are a lot of bugs in that orchard).*

"We have observed a similar trend of increasing problems with stink bugs of all kinds, including BMSB, Consperse, green, etc. In the last 5-7 years, stink bug-led rejections in almonds have been high, and we are trying to understand which species is most important. I have been doing orchard surveys in the last 4-5 years with Almond Board funding support, and we collected all kinds of stink bugs from the orchards (almonds/peach).

"The northern San Joaquin Valley, where I am based, has a pretty good BMSB population and has been causing damage to almonds since our first detection in orchards in 2017. The population has spread to Sacramento Valley (Chico area) and southern San Joaquin Valley (Fresno, Visalia) areas too. We have seen some damage in that area too, but significant damage has been in the northern San Joaquin Valley region. We are now working in collaboration with the CDFA Biocontrol Program in testing the efficacy of *Trissolcus japonicus* (BMSB-specific parasitoid) in multiple almond orchards infested with BMSB. This project can be extended to other regions, too.

"Regarding control, all stink bugs are more or less similar in terms of their feeding, where adults are likely to cause the most feeding damage. Stink bugs are difficult to kill with insecticides - timing is critical, plus what is outside of the orchard matters a lot. These stink bugs overwinter outside of the deciduous orchard and are highly polyphagous (*feed on many plant species*). So, the presence of multiple hosts in the area helps to build their population. For organic orchards, in addition to pyganic, a few additional products such as need and/or neem-pyganic combo products also work reasonably well against stink bugs in my experience. However, the residuals of these products are limited and require more frequent spraying. Recently, we updated. In 2020, I wrote a few BMSB-specific UCIPM guidelines that should help to understand this pest better, and learn more about this pest, its biology, monitoring techniques, etc. In addition, the updated guidelines have insecticides listed.

Although those are for BMSB, most of those products should work fine for other stink bug species as well. Always check the label before applying any pesticides.
https://ipm.ucanr.edu/PMG/r3303211.html

"Understanding the seasonal phenology of stink bug species is critically important for determining the best timing for control measures. Multiple companies sell the Consperse stink bug pheromone lures. Although they are less effective in orchard systems compared to field crops in my experience, they should still provide sufficient information on adult activity during the season if the pest pressure is high in the area. So, utilizing these commercially available traps and lures can help monitor Consperse stink bugs in high infestation pockets."

"We updated stink bug guidelines in peach and provided a table to identify commonly found stink bugs in the area. This might be a helpful tool as well, https://ipm.ucanr.edu/PMG/C602/m602stinkbugs.html"

So, this is what we know of the Consperse outbreak in the Santa Paula area. The grower and several of the surrounding avocado growers have sprayed with a pyrethroid which has knocked it out. The best recommendation at this point is to get the mature, ready to pick fruit off before damaged stems cause fruit drop. This will certainly be a concern if and when we get some hot winds this summer and fall. Only the low price of fruit now is halting picking decisions right now.

Insight on 2025 Honey Bee Colony Losses

Laura Leger, Department of Entomology, UC Riverside

2025 has been a rough year for the honey bees and their keepers. Reports of extreme colony mortality began in January, just before the almond bloom which requires the pollination services of an estimated 1.5 million colonies (Fenton, et al., 2025). As of July, honey bee colonies have reportedly dwindled by over 60% (https://www.projectapism.org/colony-loss-information), which is a significant increase from the average annual winter losses over the last few years (Aurell, et al., 2024). From rising costs per colony to no colony availability for their own pollination services, growers across California have no doubt felt the effects of these losses.

In response to the reports, the USDA Bee Research Laboratory in Beltsville, MD launched speedy research to investigate this year's extreme colony deaths (Lamas, et al., 2025). The research team examined *Varroa destructor* mites and pathogen prevalence in colonies from 6 different commercial apiaries prior to almond pollination services. Most notably, the research team reported that all *Varroa* mites they examined from collapsed and surviving colonies showed genetic markers for resistance to the acaricide (mite-specific pesticide) amitraz, the current primary control method for *Varroa* mite. They also found high prevalence of *Varroa* mite-vectored viruses, which are known to cause mortality in honey bees. These results suggest that the difficulty of controlling *Varroa* mite is likely the driver of the massive colony losses observed this year.

For those unfamiliar, *Varroa destructor* is a parasitic mite that feeds on honey bees and reproduces within brood cells (Figures 1 and 2), preferably drone brood cells, in honey bee hives. *Varroa* is known to transmit several viruses to bees, including Deformed Wing Virus (DWV), which can be devastating to colonies. In 2007, when "Colony Collapse Disorder" was first identified, it was linked to high prevalence of *Varroa* mite-vectored viruses. *Varroa* can be particularly troublesome during winter when colonies experience a period of dormancy known as overwintering. Colonies can be stored in temperature-controlled sheds or can be winter-proofed for the season before being assessed for their health prior to the almond bloom in February. During overwintering, honey bee queens halt reproduction. If a colony has *Varroa* mite, these isolating conditions create the perfect environment for disease to spread within the hive. Though they require brood to reproduce, mites can persist and feed on adult workers for months (Figure 3). With the halt in reproduction from the queen, there are no new workers to replace those that die from disease, which can rapidly deplete the population of an affected hive. These devastating effects are what give *Varroa* its species name "*destructor*."

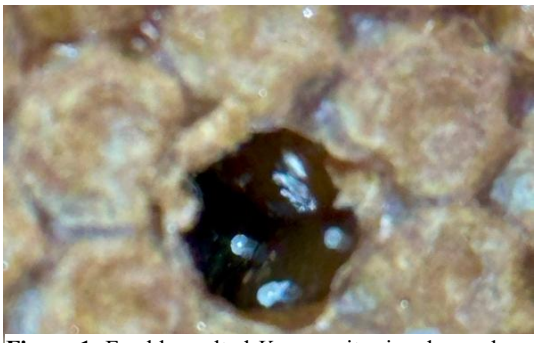

Figure 1: Freshly molted *Varroa* mites in a honey bee brood cell; Photo courtesy of Genesis Chong, PhD candidate at UCR

Figure 2: *Varroa* mite on a honey bee larva; courtesy of Genesis Chong, PhD candidate at UCR

Like all integrated pest management programming, using a variety of control methods and rotating chemical controls with different modes of action are key to preventing devastating colony losses caused by *Varroa*. Beekeepers typically employ an IPM program for *Varroa* mite that includes monitoring for *Varroa*, methods to improve colony hygiene, preventing overcrowding, removing drone brood, and chemical control. However, with so few options for chemical control, pesticide resistance can overtake even the most diligent IPM practices in honey bee colonies.

Figure 2: *Varroa* mites feeding on a newly emerged adult worker honey bee; courtesy of Genesis Chong, PhD candidate at UCR

Beekeepers now face a huge challenge in controlling mites in their colonies. In the past, coumaphos and tau-fluvalinate were used for control before *Varroa* mites developed resistance to them. Now, with the additional loss of amitraz for mite control, things are looking dismal for commercial beekeepers. Other chemical controls for mites, like DIDS (4,4'-diisothiocyanostilbene-2,2'-disulfonic acid), are currently being researched and appear to be a promising novel solution. DIDS is a substance that acts as a voltage-gated chloride channel blocker and has been shown to be an effective acaricide. However, research on this chemical is ongoing and it is not yet commercially available. Another alternative mite control method may include using exposure to carbon dioxide. Bees have a higher tolerance to carbon dioxide than *Varroa*, and some new research proposes using this as a potential way to reduce mite loads in colonies (Onayemi, et al., 2022). The downside of this method is that carbon dioxide concentrations and exposure times need to be precise and well-controlled, as it can have detrimental effects on the bees themselves if used improperly. Additionally, few beekeepers will have access to the materials needed to effectively use carbon dioxide to reduce mites in their colonies.

Until there is another reliable and commercially available control method, beekeepers will be working overtime and increasing their spending to recover their annual losses and ensure that there are enough colonies to meet pollination service demands. While honey bee colony losses can be financially damaging, it is fortunate that honey bees are well-domesticated and have a strong breeding program. Colonies lost can be replenished, but in the meantime, beekeepers will suffer the costs of lost pollination service, colony start up, and continued pest and disease treatment in the face of such extreme losses. Alternative pollination services, like purchasing commercial bumble bee colonies may seem like a solution. However, commercial bumble bee providers face production challenges and colonies available for pollination services are often limited. Altogether, this may mean continued difficulty in renting honey bee colonies and/or increased costs for pollination services for growers.

While the outlook might seem grim at this point, hope is not completely lost. It's important to note that despite acaricide-resistant mite infestations and a lack of mite control options, many colonies continue to survive. Honey bees have natural defenses like hygienic behaviors and innate immune systems that help them cope with external stressors, and the surviving colonies may show their own resistance to disease and mite infestations. Being able to investigate surviving colonies will provide excellent opportunities for researchers who study resistant traits and what causes some bees to have them while others don't. This research on the surviving bees may lead to new, more disease-resistant breeding stock for future

colonies. Lastly, researchers and organizations dedicated to promoting honey bee health will continue to study the stressors that affect bees and how to mitigate them. Pressure from the colony losses this year may spark novel research that can lead to the development or accelerated market release of new control methods against *Varroa*.

Making a healthier environment for these important pollinators can help mitigate the stressors that honey bees face. For now, supplementary floral resources like hedgerows or cover crops can provide a diverse source of nutrients necessary for bee health (https://www.almonds.com/almond-industry/orchard-management/cover-crops-and-forage). Additionally, following common sense pesticide application protocols and having a diverse IPM program can help reduce honey bee exposure to harmful substances that may be further detrimental to weak colonies. While this year was certainly a challenging year for beekeepers and growers, ongoing research and product testing should offer new solutions to safeguard honey bee colonies for future growing seasons.

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COTH2O Consorcio Tecnológico del Agua

UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources

2026 ADVANCED SCHOOL ON MICROIRRIGATION FOR CROP PRODUCTION

NEW DATES!

CLASS LECTURES: MARCH 30 - APRIL 1
FIELD TRIPS: APRIL 2 - 3

Class lectures will be held in the UC Davis Conference Center. Field trips will be in the San Joaquin Valley and Central Coast of California.

ATTENDING THIS SCHOOL WILL PROVIDE:

- 3 days of practical class lectures on principles and implementation of microirrigation systems and management practices for crop production
- 2 days of field demonstration visits (one day in the San Joaquin Valley for modernized irrigation delivery systems, and fruit and nut crops; one day in the Central Coast for vineyards, vegetable crops, and berries)

SIGN UP TO THE MAILING LIST TO GET MORE INFORMATION!

QUESTIONS? PLEASE CONTACT US:

Daniele Zaccaria - UC Davis: dzaccaria@ucdavis.edu
Mary Ann Dickinson: maryann@dickinsonassociates.com

Instructors of the School are professionals with extensive experience on principles and practical applications of microirrigation for resource-efficient crop production.

WHAT YOU WILL LEARN:

- Technical aspects of water delivery systems to allow for successful adoption and management of microirrigation systems
- Soil-water movement and soil-plant-water relations with microirrigation
- Microirrigation systems design, operation, maintenance, automation, and performance evaluation
- Methods and tools for microirrigation scheduling
- Managing microirrigation for different crops (field and agronomic crops; vegetable crops; berry crops; fruit crops; nut crops; vineyards)
- Chemigation and fertigation
- Salinity management with microirrigation

Survey on the use of Evapotranspiration (ET) for citrus production - Industry Involvement Requested

With support from the Citrus Research Board (CRB), researchers at the University of California, Davis, have created a brief survey to understand the experiences of the California citrus industry (i.e., citrus growers, orchard managers, crop and irrigation consultants, irrigation practitioners, etc.) with the use of citrus ET information. The specific purpose of this study is to appraise uncertainties and errors of citrus ET estimated with satellite remote sensing models and improve their overall accuracy. We expect this research to benefit the citrus production industry and the agriculture water management community by providing them with more accurate information about citrus ET.

If you have any survey-related questions, you may contact Daniele Zaccaria at dzaccaria@ucdavis.edu, (530) 219-7502, or Pasquale Steduto at psteduto@ucdavis.edu, (530) 703-0466.

For project-related questions, please contact the CRB Research Department at research@citrusresearch.org.

The Stakeholder Survey on Citrus ET can be accessed through the web-link and QR Code:
https://ucanr.co1.qualtrics.com/jfe/form/SV_e9h0Mw2UNqleEZM

Join UC Organic Agriculture Institute, Community Alliance with Family Farmers, RCD of Greater San Diego County, UCCE Small Farms, UC ANR Climate Smart Agriculture, USDA Natural Resources Conservation Service, and County of San Diego for two events celebrating organic agriculture in the San Diego Region!

⎔ Both events are free and include lunch. Pre-registration by 9/18 is required. The tour includes a visit to 3 organic farms. The conference includes a local buyer panel, organic marketing tools, and research updates on avocado irrigation efficiency, citrus IPM, and strategies for organic weed management

⎔ Register for 9/25: https://tinyurl.com/36jnw9zn
⎔ Register for 9/26: https://tinyurl.com/39a56bd7

Topics in Subtropics

Newsletter by Tree Crops Farm Advisors

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