



University of California Cooperative Extension

Fresno, Kern, Madera, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Tulare, & Ventura Counties

News from the Subtropical Tree Crop Farm Advisors in California

Volume 18, Winter 2019

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FARM ADVISORS AND SPECIALISTS

Ashraf El-Kereamy – Extension Citrus Specialist, UCR

Phone: 559-592-2408

Email: aelkereamy@ucanr.edu

Greg Douhan – Area Citrus Advisor, Tulare, Fresno, Madera

Phone: 559-684-3312

Email: gdouhan@ucanr.edu

Website: <http://cetulare.ucanr.edu>

Ben Faber – Subtropical Horticulture, Ventura/Santa Barbara

Phone: (805) 645-1462

Email: bafaber@ucdavis.edu

Website: <http://ceventura.ucdavis.edu>

Craig Kallsen – Subtropical Horticulture & Pistachio, Kern

Phone: (661) 868-6221

Email: cekallsen@ucdavis.edu

Website: <http://cekern.ucdavis.edu>

Sonia Rios – Subtropical Horticulture, Riverside/San Diego

Phone: (951) 683-8718

Email: sirios@ucanr.edu

Website: <http://cesandiego.ucanr.edu>

Philippe Rolshausen – Extension Specialist Subtropical Crops, UCR

Phone: (951) 827-6988

Email: philippe.rolshausen@ucr.edu

Website: <http://ucanr.edu/sites/Rolshausen/>

Eta Takele – Area Ag Economics Advisor

Phone: (951) 683-6491 ext 243

Email: ettakele@ucdavis.edu

Website: <http://ceriverside.ucdavis.edu>

Monique Rivera – Assistant Specialist in Cooperative Extension, Department of Entomology, Chapman Hall 10B

Phone: (951) 827-9274

Email: Monique.rivera@ucr.edu

Topics in Subtropics – Winter, 2019 – Published Quarterly
UCCE Tulare County, 669 County Square Dr., Ventura CA 93003
Phone 805–645 1451– Fax 805-645-1474
<http://ceventura.ucdavis.edu>

Distinguishing Between Symptoms of Drought And Root Rot in Avocado - The 12 Step Program

Ben Faber

We recently had a series of workshops on Avocado Root Rot and ways to manage it. A common question was how to figure out whether the tree was diseased with *Phytophthora cinnamomi* or just stressed from lack of water. Drought is also compounded and confused by salt accumulation, which is a reflection of how water is being managed. It might be the right amount, but not timed correctly. Too much at one time means the water goes beyond the shallow root system, too little at an irrigation and the salts contained in the water start being taken up by the roots. These “extra” salts need to be leached; otherwise, they actually compete with the tree for soil water. By “extra”, these are the salts like sodium and chloride that can be harmful to the tree, rather than the nutrient salts that are necessary for tree growth, but will also be leached when trying to achieve a balance by removing the harmful salts.

So there are several steps to follow to figure out a droughted tree from a root rotted tree. If the tree is stressed from drought, eventually though, it quite likely can lead to root rot. Looking at wilted leaves is an indication of a stressed root system which is common with a lack of water, but can happen when the roots are soaked for too long from rain, a leaky irrigation system or sediment accumulation that can occur with flooding. Wilting is also one of the first symptoms of root rot, because there are not sufficient roots to keep up with the tree’s water demand.



Step I. Wilting

Wilting is going to be the first step in alerting you to a soil/root/water problem, but it is just the first alert and there are more steps to a field diagnosis. The steps take on three different parts of the tree:

First, look at the canopy overall and then more closely in the canopy

Then, look AT the ground

Then, look IN the ground

If you look at the tree from a distance and the canopy is thinning with dieback (staghorning)



Step 2: Thinning canopy.

This means that it is something that has been going on for a longer time that just to cause the leaves to flag (wilt)



And when you look more closely, the leaves are small, yellow, have tip burn and there are lots of flowers



Steps 3, 4, 5: Small, yellow leaves; tip burn; profuse flowering

This again means that it's something that just didn't happen with a missed irrigation or two, or a stopped up emitter. Something has been going on for maybe more than a season.

And if there is fruit, if it is sunburned which means it probably isn't saleable, it means there isn't enough canopy to protect income



Step 6: Small, sunburned fruit

Now you definitely know there is a problem with the roots. The roots mirror the canopy. When they go wrong, the canopy goes wrong. All these thinning symptoms in the canopy, also means the root system is thinning. Also, when the canopy goes wrong, the roots have problems. When the canopy can't feed the root system it is less able to fend off disease, if that is the cause of the thinning canopy problem. At this point, it's not definitive that it is root rot causing the problem, but a sad canopy can lead eventually to a root rot problem because of lack of energy generated in the canopy.

The next step is to look **AT** the ground surface and see if there's natural leaf mulch. If the tree lacks energy to produce leaves, there won't be any leaf drop and now leaf accumulation. There should be leaves in various stages of brown, indicating they have been there for a while. This

mulch protects the roots from drying out and also produces an environment hostile to the root rot organism. No leaves to feed the fungi and bacteria that compete and destroy Phytophthora, eventually Phytophthora will come to dominate the system. No energy to produce leaves; no canopy to protect leaf mulch from wind? And, then the wind blows the leaves away. On hillsides, gravity can act against mulch creation and also exposes trees to more wind, but a healthy tree can create its own mulch in harsh hillside environments.



Step 7: No natural leaf mulch

With a sick canopy and no natural leaf mulch, this is the time to think there is something seriously wrong. There is something wrong with the water uptake in this tree. Either a lack of water or a lack of roots. Is it the timing, amount or distribution of the water? These are all issues that can be corrected if there is sufficient water to do so. Maybe the soil is too wet? It could be asphyxiation. Lack of air. That can be corrected by identifying the cause of the lack of air or too much water.



Step 8: Asphyxiation

But if the soil is not too wet, when you apply water, does the tree perk up? Give it a couple of days. This could always have been the problem. Does the water come on? Is a valve shut down? Is the system not working? Is there poor water distribution. This infrastructure problem is common in hillsides irrigation with cheap parts that are easily damaged by coyotes, rabbits, and pickers.



Step 9: Turn on the water

But if the tree does not or has not responded to applied water, then start digging. It's time to look **IN** the ground. This is something that should be done on a regular basis just to see how those roots are doing, anyway.

And when you start digging, there's no roots



Step 10: NO roots

Or only big roots



Step 11: Only big roots

And, if you do find any little roots, they are blackened and brittle



Step 12: dead root tips

And you have applied water and the tree doesn't perk up, then the tree probably has Avocado Root Rot disease caused by *Phytophthora cinnamomi*.

There can be other reasons, for a tree collapse like this, like a gas pipe leak, gopher activity in young trees, a chemical/fertilizer spill. Probably other things that kill roots, but a field diagnosis like this process can pretty much identify the problem as root rot. It can then be verified by a lab test to make sure. However, there are times of the year and disease conditions when a test will come back negative and it might be necessary to retest with another sample at another time of year.

Most groves that have been in the ground for many years and have been harvested by outside commercial crews quite likely have the root rot organism present in the orchard. The lack of disease is because the stress that brings on disease is lacking – water management, frost/heat damage, flooding, too much rain, too much fruit, pruning, etc. – anything that predisposes the

tree to infection. It is when several stresses are present that the trees start declining and if identified soon enough can be corrected and the decline stopped and reversed.

Avocado Trunk Cankers

Ben Faber

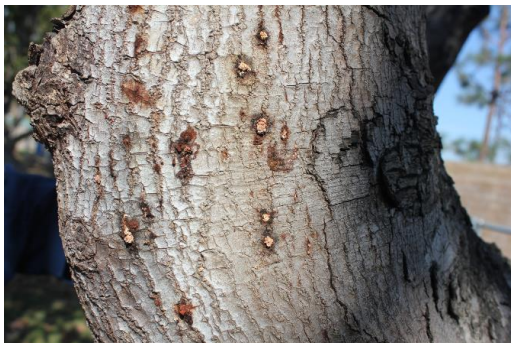
There are a number of causes for the white exudate from cankers on the trunk and limbs of avocado. Any wound will cause the tree sap to run and crystalize on the surface. It is a seven-carbon sugar of mannoheptulose, or its alcohol form perseitol. It's sweet. The leaking sap is the tree's attempt to staunch the wound (More about the sugar can be found at: <https://www.sciencedirect.com/science/article/pii/S0254629911001372>). Any wound that might be caused by woodpeckers, pickers or little kids climbing the trees will damage the bark, and where the damage has occurred, the sugar will form. So fire damage can cause wounding and so can insect infestation like shot hole borer. Any wound will cause the sugar to leak out in a response to heal the damage. This sugar exudate is a sign of health in the tree, showing that it can respond to attack/infestation/disease. No response is a bad sign.



Physical damage from kids clambering around in a tree



Fire/heat damage exudate



Shot Hole Borer Damage

There are also diseases that can cause a wound that will exude the sugar sap. Three of these are due to water stress of some form that allows infection to occur. These cankers can be quite a problem in avocado, as well as some other tree species, during drought years. With rainfall, the sugar stain is washed away and if there is adequate rainfall, the cankers might even heal. But they can easily reappear once the right stress conditions reappear. The other tree species don't exude the white sap, which is unique to the laurel family. The cankers have also appeared regularly in orchards that have irrigation and salinity management problems. All of these diseases can lead to unthrifty looking trees, which can lead one to conclude that they have Avocado Root Rot. Often, though the trees can have the cankers and the whole canopy can look quite healthy.

One of these trunk cankers is bacterial – Bacterial Canker – caused by *Xanthomonas campestris*. The name "campestris" means "field" in Latin, and it is a bacterium commonly found in nature. So the bacterium is widespread, and it is not unusual to see a large part of an orchard infected, but it is not commonly found in most orchards. The infection causes a pocket of infection that will ooze sap. The oozing pockets will often appear in a series along a branch or the trunk. It is associated with poor water distribution, and irrigation timing and

water/salinity stress. It can be quite a sight, but it rarely kills trees and when the water problems are identified and corrected the cankers will dry up on their own. More on Avocado Bacterial Canker: <http://ipm.ucanr.edu/PMG/r8101111.html>.



Bacterial Canker

A group of fungi, which we once labelled as *Dothiorella*, causes another canker but we now know a much larger group of fungi that includes *Botryosphaeria* and *Phomopsis* causes the canker. On leaves, the symptoms are called blight; on stems, called dieback and on larger branches and trunks, called simply cankers. UCR plant pathologists have actually identified at least seven different species of fungi that invade the wood and can eventually weaken the tree so limbs can break and the tree becomes unthrifty. In the case of very young trees, they can be killed by these fungal infections, so they are pathogenic. They also are saprophytic on dead tissue and can survive in mulch. The cankers will appear in blotches or patches on the trunk and branches.

Again, these cankers most commonly occur in orchards with irrigation management problems, although there are exceptions where it is unclear what the underlying cause might be. When drought issues are addressed, these cankers will often heal on their own. Read on about Dieback and Canker : <http://ipm.ucanr.edu/PMG/r8100611.html>.



Trunk Canker

The third cause of sugary cankers is Black Streak, the cause of which has been unclear. It has been tested as a virus, viroid, fungus and bacteria, but it does not seem to fall into any of those groupings. It acts like Trunk Canker, but so far, it has defied a fungal classification. Unlike Trunk Canker, it will usually show up as a widely scattered area of small cankers, often on the undersides of branches and along the trunk.

The correction is similar to Trunk Canker and they mostly appear after a low rainfall year, where irrigation pressures are insufficient, where emitters have clogged and where general water or salinity stress has occurred. More on Black Streak: <http://ipm.ucanr.edu/PMG/r8100311.html>.



Black Streak

The bacteria and fungi that cause these cankers are everywhere in most orchards and are just waiting for the stressed tree to appear. The grower just needs to identify where this stress is occurring, correct the problem (clogging, low pressure, poor irrigation design, infrequent scheduling, inadequate leaching, etc.) and if the damage is not too extensive, often these symptoms will disappear with time.

The fourth cause of canker is caused by *Phytophthora menzei* (previously *P. citricola*); a relative of Avocado Root Rot called Crown Rot, but this fungus attacks the crown roots and lower trunk. The environment that encourages this canker is a moist trunk, either from irrigation water hitting the trunk, or on the north side of the tree that doesn't dry out from morning dew/fog/rain. This is a much slower acting disease than root rot, although it can rapidly kill young trees. The cankers occur at about 18 inches from the ground and gradually girdle the tree. The first thing to do before ever seeing this disease is to make sure irrigation water isn't hitting the trunks. If you do have cankers appear, though, it responds to the same materials used for root rot control, but the materials should actually be sprayed right on the canker.



Crown Rot

So here we have four different trunk diseases all caused by water management. The first three usually from amount and timing and how salts are managed. Crown Rot really is simply irrigation splash on trunks. All four of these can easily be managed with improved irrigation management. You can read more about drought-induced problems in orchards at: <https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=20381>,

Viruses are your friends, and maybe for citrus, as well?

Bryce W. Falk

Distinguished Professor

Department of Plant Pathology, UC Davis

bwfalk@ucdavis.edu

Viruses are the most abundant microbes on our planet. All cellular organisms have viruses, and even some viruses have viruses. Human chromosomal DNA has more virus-derived sequences than genes, and these viral sequences are major drivers of evolution. Estimates are that there are ten fold more virus particles than there are cells on earth. Most of the known viruses have been discovered because of the diseases they cause, however, contemporary metagenomics studies have shown that there are many previously unrecognized yet highly abundant viruses, and most are not associated with diseases. Many of these are virus types that are new to science, and wildtype or modified versions of some might have potential benefits for new approaches to protect human, animal or plant health. Some examples and possibilities are presented below.

Respiratory enteric orphan (Reo) virus is a ubiquitous and benign human virus. However, recent research has shown that it also has oncolytic activity. That is while it is benign in healthy cells, it can kill certain types of cancer cells. Now a proprietary isolate of this virus (REOLYSIN) has been granted Orphan drug status for treating malignant glioma, and it is on Fast Track for treating metastatic breast cancer. See <https://www.youtube.com/watch?v=98ltOLxHKK4> for more information.

We also have tools now to modify viruses and use them for specific benefit. One interesting and very successful application of using a genetically modified virus in the environment is for rabies control (<https://www.who.int/rabies/vaccines/recombinant/en/>). Here a pox virus, vaccinia virus, has been modified to express the rabies virus glycoprotein, and the recombinant virus is included in baits that are spread even by air drops to locations where foxes, raccoons, skunks and coyotes are common. These animals eat the baits, and the vaccinia virus gives a non-pathogenic infection but also induces immunity to rabies virus, thereby preventing rabies epidemics among wild animals. Since 1987, over 250 million doses of recombinant vaccinia virus have been applied to the environment in the U.S. and Europe with only positive results.

What about using viruses in plant-based agriculture? We already are in some cases, and new approaches are being evaluated. Already hundreds of millions of citrus trees in Brazil have been intentionally inoculated with a mild form of citrus tristeza virus. This gives “cross-protection” to these trees, preventing their infection by severe isolates of the same virus (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3616238/>). Recently, citrus tristeza virus also has been genetically modified in attempts to combat citrus greening (Huanglongbing) and is being evaluated in field trials in Florida (https://www.aphis.usda.gov/brs/aphisdocs/17_044101r_CTV_ppra.pdf ; https://citrusresearch.org/wp-content/uploads/CitrographQ1-2016-OE_Ng.pdf).

A relatively new approach being evaluated for insect-transmitted pathogens of both plants and animals is to use insect-specific viruses to interfere with the ability of insect vectors to transmit specific pathogens to their animal or plant hosts. Insect-specific viruses only infect insects and do not cause pathogenic effects in their insect hosts, they are components of the microflora of their insect hosts. Research has shown that some insect-specific viruses can directly interfere with human pathogens in the mosquito vector, negatively impacting pathogen transmission to vertebrate hosts. But we need more. New efforts are now underway to modify insect specific viruses to have greater efficacy towards disrupting pathogen transmission by insect vectors of plant and animal pathogens.

Viruses are ubiquitous microbial components of our environment. Relatively few are pathogens, and those that are not pathogens offer great opportunities for new, environmentally sound biological-based opportunities for developing new strategies for plant and animal disease management.

N.B.

The recent conferences on Citrus Viruses and Citrus HLB were held in Riverside. There were extensive presentations on the intricacies and workings of viruses in citrus, their interactions with HLB bacteria and ACP. The agenda is included here and the abstracts will soon be available through the Citrus Research Board website:

http://www.citrusresearch.org/wp-content/uploads/CRB-IOVC-MiniProgram-022619_V2.pdf

There will also be a summary of the Conference during the June CRB regional meetings.

Ground Squirrel and Other Vertebrate Management Issues in Citrus and Avocado Orchards

Niamh Quinn

UCCE Human-Wildlife Interactions Advisor

nmquinn@ucanr.edu

Do you have California ground squirrel issues and are unsure what to do about them? Are they girdling your trees, chewing on your irrigation lines? Have they burrowed into hillsides so much that you are worried about erosion and collapse? What about burrowing on your levees? Did you know that burrowing rodents are the one of the top causes of levee collapse in the state?

Check out this resource from University of California's Division of Agriculture and Natural Resource. [The ground squirrel best management practices website](#) provides information on everything from biology to regulations. This site can help you identify if your issues are caused by ground squirrels or if some other vertebrate pest is causing you trouble. It provides detailed information on trapping, fumigation (including pressurized exhaust systems), the use of toxicants and many other management options. There is information on which practices are considered the most efficacious and what time of year they are appropriate to use. The site also provides step-by-step instructions on how to construct bait stations, calculate CO2 flow and how to calibrate a spreader for broadcast bait applications.

If you are unsure about what the regulations concerning ground squirrel management, there is also lots of detail about this on the website. It provides information on the licenses required for ground squirrel management. It is important to always be aware of what endangered species exist in your production

areas. On the website, there are detailed maps which outline the distribution of these endangered species and provide information on how the management of ground squirrels could impact these species.

Ground squirrels are vectors of plague. It is important to be aware of this and flea management when managing ground squirrels. For more information on plague and flea management, you can check out the website.

If you are interested in learning more about California ground squirrel management (<http://ipm.ucanr.edu/PMG/PESTNOTES/pn7438.html>), the author of this peer-reviewed site will be presenting at the CAS/CAC/UC Avocado Meetings June 11, 12, 13 in San Luis Obispo, Ventura and Fallbrook - <https://californiaavocadosociety.org/seminars.html>.

And if you have questions about other large animals in your grove, she can answer most of those too.



Meet our new Citrus Specialist at UC Lindcove REC



On February 1, 2019, Dr. Ashraf El-Kereamy was appointed as a Cooperative Extension Specialist in the Department of Botany and Plant Sciences at UC Riverside. He is hosted by the University of California Agricultural and Natural Resources (UCANR) at Lindcove Research and Extension Center (LREC). His primary responsibility is citrus horticulture and to develop a comprehensive local, as well as statewide, research and extension educational program. This program will help the citrus industry in maximizing its production and improving its efficiency while facing ongoing and emerging challenges. During the past four years, before joining the UCR, Dr. El-Kereamy worked as a Viticulture Advisor serving Kern County. Dr. El-kereamy majored in Horticulture at Ain Shams University, Egypt, obtained a Master of Science in Pomology from the same university, and later acquired a Ph.D. in Agriculture with an emphasis in Grapevine Physiology and Molecular Biology from Toulouse University, France. He earned his Ph.D. at one of the most remarkable plant hormone laboratories in Europe and became a well-known author of ethylene

and anthocyanin production in grapes. He has extensive post-doctoral research experience in several commodities revolving around plant hormones, fruit ripening, plant nutrition and the responses of different plant species to Abiotic stress conditions.

Also, during his post-doctoral research, he published several papers on Nitrogen use efficiency in different crops and two international patents on heat stress responses in rice plants. He is currently working with the industry and university partners to determine the needs of the California citrus industry to implement an excellent applied research and extension program at Lindcove Research and Extension Center.

Dr. El-kereamy is very enthusiastic about the position and being located at the heart of the citrus industry at LREC. He believes it is the perfect place to interact with the citrus industry and design the research, extension, and outreach programs based on their needs. He is very anxious to help the citrus industry with all of his knowledge and experience. Please contact him if you have any questions or concerns related to citrus physiology or cultural practices.

Ashraf El-kereamy, Ph.D.
Cooperative Extension Specialist
University of California Riverside
Department of Botany and Plant Sciences
Riverside, CA 92521

Mailing Address:

Lindcove Research and Extension Center
22963 Carson Ave.
Exeter CA 93221
Telephone: 559-592-2408
Cell: 661-703-4678
e-mail: aekereamy@ucanr.edu

Meet our new Tree Crops Spray Application Engineer at UC Kearney REC



Dr. Peter Ako Larbi is a Cooperative Extension Specialist in agricultural application engineering with UC ANR. As part of his research and extension program, his focus is on developing and promoting best practices for safe, economical, and environmentally sound pesticide application with reduced environmental risks. He is based at the Kearney Agricultural Research and Extension Center in Parlier.

Prior to joining ANR, Dr. Larbi had been an Assistant Professor of Agricultural Systems Technology in the College of Agriculture at Arkansas State University since 2014. He developed an integrated teaching and research program related to agricultural systems technology; developed and managed research in precision agriculture, agricultural machinery systems, remote sensing and sensor technology; and provided service to the university, college, local community and general scientific community. He held a joint appointment in the Division of Agriculture at University of Arkansas.

Dr. Larbi was recognized by the Program Assessment Committee and Office of Assessment at Arkansas State University as February 2017 Professor of the Month. He was also awarded the 2017-2018 Outstanding Graduate Faculty Mentor by the Graduate Student Council for his dedication to student success. For his contributions to research and education in the field, he also received the prestigious Young Engineer of the Year Award in 2017 from the Arkansas Section of the American Society of Agricultural and Biological Engineers (ASABE). He was also a recipient of the Mondialogo Engineering Award and a Special Jury Recognition Award in 2005 from the United Nations Educational, Scientific and Cultural Organization (UNESCO) in partnership with DaimlerChrysler.

From 2012 to 2014, Dr. Larbi was a postdoctoral research associate at the Center for Precision and Automated Agricultural Systems at Washington State University. From 2011 to 2012, he was a postdoctoral researcher at the University of Florida Citrus Research and Education Center.


Larbi earned a Ph.D. in agricultural and biological engineering from University of Florida and a M.Sc. and a B.Sc. in agricultural engineering from Kwame Nkrumah University of Science and Technology in Kumasi, Ghana.

Dr. Larbi invites you to kindly take the following needs assessment survey to help him assess outreach, education, and training needs in pesticide spray application to better plan and implement a program that serves the people of California well:

https://ucdavis.co1.qualtrics.com/jfe/form/SV_0qvaddZ6Se5QIrr

Please contact him at palarbi@ucanr.edu if you need further information. Thank you very much for your assistance.

Dr. Peter Ako Larbi
Kearney Agricultural Research & Extension Center
9240 S. Riverbend Ave.
Parlier, CA 93648
559-646-6577

palarbi@ucanr.edu 

<http://www.kare.ucanr.edu>

UC Ag Experts Talk

“Everybody is busy,” said [Beth Grafton-Cardwell](#), UCCE citrus entomology specialist. “It’s hard for people to get to meetings. Now, they can get some of the hours they need for updating their professional licenses from home or work, or even on their smartphones.”

A new series of 1- hour webinars, designed for growers and Pest Control Advisors, will highlight various pest management and horticultural topics for citrus and avocados. During each session, a UC Expert on the subject will make a presentation and entertain write-in questions via chat during and/or after the presentation. As we develop this program, we may expand to other crops.

Who is involved?

This webinar series is brought to you by Ben Faber (UC ANR Ventura Advisor) and Dr. Beth Grafton-Cardwell (Depart of Entomology UC Riverside Extension Specialist) with the technical support of Petr Kosina (UC IPM Contact Development Supervisor) and Cheryl Reynolds (UC IPM Interactive Learning Developer).

Are there Continuing Education units?

When the subject discusses pest or disease management, continuing education units will be requested from DPR (1 unit per session). Participants will pre-register, participate in the webinar and be awarded the unit. The sessions will be recorded and hosted on this web site for future study. However, continuing education units will be awarded only to the participants who attend the live version of the webinar.

Professional pest control advisers must complete 40 hours of continuing education every two years; qualified applicator certification and qualified applicators license renewal requires 20 hours every two years, [according to the California Department of Pesticide Regulation](#).

Recent webinars have covered “Citrus Thrips” by Beth Grafton-Cardwell, “Avocado Root Rot” by Ben Faber, “Respirators” by Lisa Blecker, “Fuller Rose Beetle” by Grafton-Cardwell, “Citrus Nematodes” by Ole Becker and “Laurel Wilt Disease” by Monique Rivera.

Upcoming webinars:

Management of Glyphosate-Resistant Weeds in Orchard Crops (April 24, 2019 from 3-4pm)

Dr. Brad Hanson, Cooperative Extension Specialist, will discuss what is herbicide resistance, current state of resistant weeds in CA permanent crops, identification and lifecycle of key glyphosate-resistant weeds, selection pressure for resistant biotypes and species, herbicide modes of action, and examples of herbicide programs for orchard crops. One DPR CE unit (other) and one CCA CE unit (IPM) are pending.

Snails and Slugs (May 22, 2019 from 3-4pm)

Presenters: Drs. Cheryl Wilen (UC IPM), Rory Mc Donnell and Dee Denver (Oregon State University), Adler Dillman and Irma DeLay (UC Riverside) will cover overview of snail and slug biology, damage and management with emphasis on brown snail and Italian white

snail, and current research on slug biocontrol using nematodes. One DPR CE unit (other) and one CCA CE unit (IPM) are pending.

Register in advance for upcoming webinars at: <https://ucanr.edu/sites/ucexpertstalk/>



Cooperative Extension
University of California
669 County Square Dr.
Ventura, CA 93003



Ben Faber
Farm Advisor

Topics in Subtropics



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University of California, Agriculture and Natural Resources, 2801 Second Street, Davis, CA 95618, (530) 750-1397. Email: jsims@ucanr.edu.

Website: http://ucanr.edu/sites/anrstaff/Diversity/Affirmative_Action/.

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