University of California Cooperative Extension Subtropical Horticulture News

Quarterly Newsletter for Subtropical Horticulture Growers in Riverside & San Diego Counties
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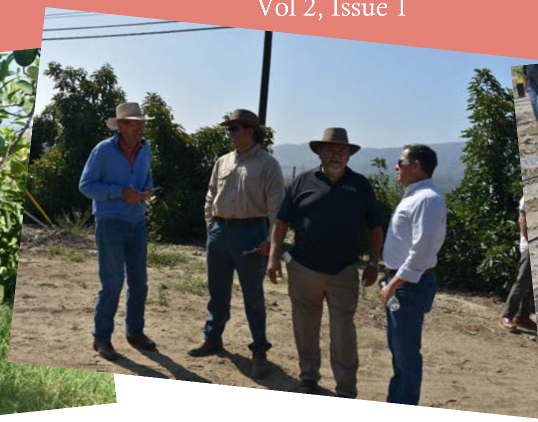

Hello Subtropical Horticulture Community, it's unfortunate that COVID-19 still has such a huge influence on our everyday lives. I also want to apologize for not coming out with another newsletter sooner, even with COVID, Farm Advisors are busier than ever these days!

My avocado course was a success! Currently, the citrus production course in half way through. I'm excited and glad to see so many grower's strength their current skill set and others who want to advance their basic knowledge as a new grower.
I also look forward to seeing everyone at the San Diego County South American Palm Weevil Symposium mid-month, it is a free 2-day webinar with many types of continuing education units for licenses.

We want this newsletter to be valuable for you so *please,* share your feedback and suggestions to help us improve. Don't forget to sign up for the quarterly newsletter, Topics in Subtropics (Please contact our San Diego office and request to be placed on my email list (cesandiego@ucanr.edu) and join the Topics in Subtropics Blog **https://ucanr.edu/blogs/blogcore/subscribe.cfm**

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University *of* California
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Invasive Insect Pests in Avocados

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Globally, invasive insect pests cause substantial damage to agricultural crops and natural environments. In the United States (U.S) alone, crop and forest production losses from invasive insects and pathogens have been estimated at almost $40 billion per year (Pimentel et. al. 2005). On average, a new non-native invertebrate is introduced into California every 40 days and with respect to insects and mites, about 1/3 of these become pests (Dowell et al. 2016) and economic losses and in California are estimated at more than $3 billion per year (Metcalf 1995).

Rapid growth of U.S. demand for fresh avocados has increased the fruit's prominence in retail sales and diets. California (CA) is the largest producer of avocados grown in the U.S. The value of U.S. avocado production measured at approximately $392 million in 2017, (NASS, 2018). There are more than 3,000 avocado growers in the state farming on approximately 50,000 acres of land with Ventura County leading the state in most acres planted and harvested in recent years (California Avocado Commission [CAC], 2020). CA avocados are particularly special, because less than 1% of the state is suitable for growing them. A healthy, single 'Hass' avocado tree can produce up to 200 pounds of fresh fruit each year, which is ~ 500 pieces. In 2018 alone, CA produced around 350 million pounds. Avocados are considered a specialty crop and are not cheap to grow because of water and land costs and fruit therefore usually demands a high premium price. Traditionally, insecticide use in California avocado orchards has been minimal due to relatively few pest species, which for the most part, have been under adequate levels of biological control (Hoddle 2005). However, due to the increase of international trade, illegal importation, and the smuggling of foliage, branches with leaves, whole plants, and budwood invasive insect and mite pests have begun to threaten the economic viability of avocado production in CA.

Most common symptoms of the disease include sugar or gum exudates. Photo Credit: Sonia Rios

Current: ***Polyphagous and Kuroshio Shot Hole Borers***
Polyphagous Shot Hole Bore (PSHB), is an invasive ambrosia beetle from Southeast Asia that was first detected in Los Angeles County in 2003 (Gomez et al. 2018, Rabaglia et al. 2006).
PSHB is a pest of great concern in Southern CA, it can attack over 300 tree species and reproduce on a subset of these that are capable of supporting beetle reproduction and growing the fungi that cause fusarium dieback. PSHB has a strong symbiotic relationship with several fungi, including *Fusarium euwallaceae* and *Fusarium kuroshium*, the causal agent of Fusarium Dieback (FD) disease (Eskalen et al. 2013). The list of reproductive hosts includes several native oaks, maples, sycamores, willows, and avocado. The fungus disrupts the vascular transport of water and nutrients on their host tree that eventually causes branch dieback. The most common symptoms of the disease include sugar or gum exudates, dieback, wilt and ultimately host tree mortality. Reports of dieback symptoms in El Cajon, San Diego County led to the discovery of another species, the Kuroshio shot hole borer (KSHB) in 2013. KSHB is also present in commercial avocado orchards in San Diego County. The KSHB was originally limited to the San Diego region, but has since spread to Orange, Los Angeles, Ventura and Santa Barbara Counties.

Presumably, the PSHB and KSHB were introduced accidentally into Southern California via wooden products and or shipping material (e.g., pallets and dunnage) from Southeast Asia. KSHB is morphologically indistinguishable from PSHB but can species can be separated using molecular techniques.

Beetle Life Cycle and Fusarium Symptoms

The fungus gets into the woody tissue of the tree when a female PSHB excavates a gallery and inoculates the gallery walls with fungal spores that it carries in special structures called mycangia (Beaver 1989). The female PSHB and her offspring feed exclusively on the fungal spores. PSHB adults engage in sibling mating within the natal gallery. Offspring sex ratios are female biased to maximize reproductive output such that one male can inseminate many of his female siblings. Once fully developed and mated, female PSHB exit their natal gallery to start a gallery of their own and repeat the cycle. Unlike their sisters, male PSHB do not disperse since they are not capable of flying and do not possess mycangia, which are specialized structures for fungus storage.

Best Management Practices for PSHB

Pesticide efficacy may be limited, and this attributed to the fact that PSHB's feed on fungi and not directly on wood tissue. This reduces exposure to active ingredients when feeding (Eatough Jones et al. 2017). Cultural management practices include (UC IPM 2017): (1) removal of infected branches to reduce local beetle numbers and fungal spread in the infested area; (2) chipping (< 1 inch) and solarizing infested wood; (3) avoiding movement of infested materials to new areas, if transportation of materials is necessary, it must be covered. These management strategies can perhaps abate the severity of local infestations. Also limiting the spread of infected/infested trees include minimizing firewood transportation. Sterilize pruning tools with household bleach or another cleaning solution can reduce the spread of the FD pathogen. The PSHB was found in Israel in 2009 in commercial avocado orchards where it damages trees. To date, there has been no avocado tree fatality due to the PSHB or FD in CA. For more information regarding PSHB, visit: https://ucanr.edu/sites/pshb/

Potential threat to CA: Redbay Ambrosia Beetle and Laurel wilt Complex

Laurel wilt branch die back on avocado. Photo Credit: Sonia Rios, UCCE Riverside/San Diego

An invasive ambrosia beetle, the redbay ambrosia beetle (RAB; *Xyleborus glabratus*), is a serious pest currently spreading through the Florida avocado industry and has been responsible for significant yield reductions since its discovery in 2005. The beetle was first detected in the U.S in Port Wentworth, Georgia in 2002 and was probably introduced via infested wooden packaging material (Crane 2011). This beetle has been slowly spreading across the southeastern U.S and is currently found as far west as east Texas. Therefore, CA growers need to be aware that this pest-disease complex may spread to CA avocados. What makes this complex dangerous is that the vector, the RAB has a symbiotic relationship with the fungal pathogen, *Raffaelea lauricola*, that causes Laurel Wilt Disease (LWD). Native to Southeast Asia, RAB has similarities to our current ambrosia pests, PSHB. However, the fungus associated with LWD is unlike the disease here in CA. Trees become infected when female beetles attack host trees and introduce the pathogen into the xylem while boring their galleries. The infection restricts the flow of water in the tree, induces a black discoloration in the outer sapwood and causes the leaves to wilt (Photo 3). Tree mortality is so rapid that leaves do not fall from dying branches.

Symptoms of RAB beetle and LWD infestations include (Carrillo et. al. 2017):
1. Wilting of leaves and young stems. You can usually see dead leaves hanging on branches.
2. Color change in leaves from light green to dark purplish green or greenish brown.
3. Stem and limb dieback.
4. Trunk and major limbs that show dried sap which has a white appearance and is a crystalline, powder-like material.
5. Dark streaks in the sapwood. Normally sapwood should be white to yellowish-white in coloration with no dark staining or streaking. To check for this symptom simply remove a section of the bark to check for discoloration, which if present, may indicate fungal infection.
6. Small, dark holes in the sapwood (Photo 5) and what looks like loose wood dust and frass indicate wood boring beetles are present (Photo 6).

The Beetle's Life Cycle
LWD affects redbay (*Persea borbonia*) and other tree species of the Laurel family (*Lauraceae*), including avocado. *R. lauricola* is introduced into host trees when adult RAB colonizes a tree. Adult RAB are very small (~1/16-inch-long), dark brown to black in color and spend most of their life within the tree. Larvae are white, legless grubs with an amber colored head capsule and are found within galleries throughout infected trees. Female beetles can produce flightless male offspring without mating, but females may mate with their male offspring or brothers to produce males and females. Females greatly outnumber males in populations. In the Southeast US, the RAB's lifecycle from egg to adult appears to take 50-60 days, and there appear to be multiple overlapping generations per year (Hanula et al. 2008). Female beetles emerging from galleries may reinfest the same tree or disperse in search of new hosts. Host trees can remain standing for years and may continue to serve as host material for beetles for several months after initial colonization. Flight activity peaks in the late afternoon and early evening.

Best Management Practices for RAB and LW
It is known that ambrosia beetles are notoriously difficult to control with insecticides because they are protected from residues by living inside the tree most of their life versus being outside the tree. RAB can fly short distances, but laurel wilt fungus spreads more quickly through the movement of insect infested plant material, such as firewood. Additionally, the pathogen also spreads to other ambrosia beetle vectors. This happens when beetles feed on diseased trees and become contaminated with spores of *R. lauricola*. Spread can also occur through root-grafting between trees. Sanitation is the most effective way to manage this problem. Scouting for wilted branches and quickly removing them has been key to successful early intervention and eradication. It has been suggested to remove symptomatic trees immediately upon their identification. However, once the appearance of frass and streaks start to show in the wood, this is a sign that the tree has already been infected and has been for some time. As soon as a grower sees the wilt in the branches, it's time to move quickly. Verticillium wilt and Phytophthora root rot can be mistaken for laurel wilt so avocado growers should check for these diseases before removing trees.

The Florida avocado industry has implemented a universal detection and suppression program with the goal of preventing or limiting the incidence of LW in commercial groves and depressing ambrosia beetle populations (Carrillo et. al 2017). Surveying for the symptoms of laurel wilt is a key component to limiting the spread of the disease. Growers and their workers should survey groves weekly or more often if an infestation is detected in an adjacent grove. Early detection, removal and destruction of LW affected trees is the most important practice for controlling LW. Contact insecticides are ineffective because the pathogen vectors (i.e., the ambrosia beetles) are primarily inside the tree. The first goal is to avoid infestation with the beetles by maintaining a healthy tree as stressed trees are more attractive to colonizing beetles. Beetles prefer trees in orchards that have dense canopies with overlapping leaves and branches.

RAB entry holes in avocado. Photo Credit: Sonia Rios, UCCE Riverside/San Diego

Chipping infected trees is effective in reducing the spread of the disease. However, chips must be as small (1 square inch pieces or smaller) as possible and dried quickly so that the wood is not conducive to fungal growth. A potential drawback to this method is that the aroma of the chipped wood can attract other wood boring insects. Research in Florida is currently being conducted to determine if different commercial formulations of insecticides can be effective in controlling the beetle. For more information regarding LW and RAB, please visit: https://sfyl.ifas.ufl.edu/miami-dade/agriculture/laurel-wilt---a-disease-impacting-avocados/ .

Fairly Recent: Avocado Lacebug

Avocado lace bug adult and eggs. Photo Credit: Mark Hoddle, Center for Invasive Species Research, UC Riverside

The avocado lacebug (ALB), *Pseudacysta perseae* (Hemiptera: Tingidae) was first detected in California on backyard avocado trees in the Chula Vista and National City San Diego County, CA in 2004. This pest was first described in Florida in 1908 and has since been reported from Mexico, Guatemala Puerto Rico, Jamaica, the Dominican Republic, and parts of northeastern South America. The native range of ALB is uncertain. Molecular studies suggest that the western areas of Mexico may be the evolutionary center of origin for this pest and it was spread unintentionally from this area, probably on avocado trees into eastern Mexico, Florida, and the Caribbean (Rugman-Jones et al. 2012).

After a lull of approximately 13 years, reports started coming of ALB damage to avocados outside of San Diego. In October 2017, well established, reproducing populations of lace bugs were confirmed in commercial Hass avocado groves in Oceanside and De Luz in San Diego County and in Temecula in Riverside County (CAC, 2017). Around this time infestations were reported from backyard avocados in Culver City in Los Angeles County. Genetic analysis suggested that these new more damaging populations of ALB were different to those originally detected in San Diego in 2004, and it's likely that a second introduction of ALB into CA has occurred, possibly from Florida (Rugman-Jones and Stouthamer unpublished molecular data).

ALB has been recorded feeding on avocado, red bay, and camphor, which are all in the Lauraceae.

Description and Life Cycle

Avocado lace bug is a true bug with sucking mouth parts. Lace bugs use these needle-like mouthparts to feed on the undersides of leaves. Through feeding leaf cells and pierced, cell contents are extracted and ingested and feeding damage prevents photosynthesis.

Adult avocado lace bugs are small winged insects about 2 mm in length (slightly longer than 1/16 in) with black bodies, yellow legs and antennae, and are visible to the naked eye (UC IPM 2021). ALB live in colonies on the lower surfaces of mature leaves, often adults, eggs and nymphs are found together. Eggs are laid in an irregular pattern, sometimes in loose rows, attached to the lower leaf surface and are covered with irregular globules of a black, sticky tar-like substance excreted by adults. To the naked eye, eggs will appear like grains of black pepper or dirt.

Eggs hatch into wingless young called nymphs that are capable of walking. Nymphs go through a gradual metamorphosis shedding their exoskeleton several times as they grow in size, finally developing wings and becoming flying adults. Nymphs are dark red-brown to black and covered with spines. They feed for approximately two to three weeks before maturing into adult males and females which mate, and females then lay eggs, starting the cycle over. In California, ALB populations tend to peak over early summer, around June, then decline in fall, sometime around September (Humeres et al. 2009).

Symptoms

Severe feeding damage to avocado leaves caused by avocado lace bug. Photo Credit: Mark Hoddle, Center for Invasive Species Research, UC Riverside

ALB restrict their feeding to the undersides of leaves. Feeding initially causes small white or yellow spots on the surface of the leaves as individual cells dry out. These necrotic areas look like tip-burn caused by excessive salts, but in this case the necrotic areas are islands of dead tissue in the interior of the leaf surrounded by living tissue. It is suspected that feeding damage can provide entrance for pathogenic fungi, in particular *Colletotrichum* spp., which are leaf anthracnose fungi. As lace bug colonies grow, brown necrotic (dead) areas develop where there has been heavy feeding damage. Heavy feeding can cause striking leaf discoloration and early leaf drop (Hoddle 2004; Hoddle et al. 2005). Avocado lace bug nymphs and adults do not feed on fruit. However, heavy feeding damage to leaves will likely have a detrimental effect on yield which may result from the loss of photosynthetic capacity in damaged leaves.

Best Management Practices for Avocado Lacebug
Relatively little is known about biology and ecology of ALB in California. In Florida, the most important biological control agents are two egg parasitoids including *Oligosita* sp. (a Trichogrammatid wasp) and an unidentified mymarid wasp. Green lace wing larvae and other generalist predators are also thought to be important natural enemies. A predatory thrips, *Franklinothrips vespiformis*, is reported to be the most important natural enemy of the avocado lace bug in the Dominican Republic and is similarly abundant on ALB infested avocados in Escuintla Guatemala.

Insecticides treatments for other sucking pests currently registered for use on avocado in CA will likely provide control of avocado lace bugs (Hoddle et al. 2005). In a trial reported in 1998, J. E. Peña, University of Florida, showed that citrus oil, M-Pede (soap), and Mycotrol (a Beauveria fungal species) all controlled lace bug, but it was not indicated how long the effect lasted. Researchers at the UF have shown that citrus oil, and M-Pede (an insecticidal soap) provided short-term lace bug control. Results of small tree trials or weathered residue tests have indicated that carbaryl, imidicloprid, cyfluthrin, carbaryl, fenpropathrin, and malathion provide excellent control of avocado lace bug nymphs. Spinosad, abamectin, and mineral oil are much less effective at providing control (Humeres et al. 2009b; Byrne et al. 2010). For more information on lacebugs, please vist: https://biocontrol.ucr.edu/avocado-lace-bug.

The Concept of Proactive Management and Early Detection
The concept of early detection and rapid response is fundamental to effective invasive species management. Developing collaborative relationships with avocado research colleagues in different countries can provide insight into new potential pest problems that could eventually find their way to CA (Hoddle et al. 2009). Developing this idea further can result in the development of proactive biological control and IPM programs in advance of the anticipated arrival of new pest species (Hoddle et al. 2018).

Ideally, finding a new pest species in the early stages of the invasion and quickly containing and treating the new infestation may reduce costly long-term management, especially if eradication is possible. Rapid and decisive containment actions are an important consideration as controlling invasive pests, especially fruit feeders, in CA avocado orchards will always be a challenge and expensive should they establish widely.

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New California Pest Announcement: Black Fruit Fly

The Situation:

Fig growers need to be aware of the black fig fly (Lonchaeidae: *Silba adipata*) (BFF), an invasive insect that was recently discovered infesting figs in multiple counties in southern California. University of California Cooperative Extension (UCCE) personnel are currently working with the California Department of Food and Agriculture (CDFA) to further delineate populations as well as develop improved monitoring and management strategies. This pest has been designated as an "A" priority through the CDFA. The BFF attacks figs and prefers unripe and unfertilized fruits. The adult female deposits eggs into the fruit through the ostiole and larvae subsequently feed internally on the fruit. This feeding damages the fruit and causes it to prematurely drop from the tree. Upon completion of development, the BFF larvae chew their way out of the fruit, drop to the soil and pupate. In some cases, BFF pupae have been recovered inside of fruits as well. Black fig flies overwinter as pupae in the soil. In the spring they emerge, mate and begin to attack figs. The BFF can have between 4-6 generations per year (more in warmer areas, fewer in cooler areas). Biological control appears to be limited and there are currently no chemical controls registered for this pest on California figs. Orchard sanitation is critical, and growers should make sure to remove and destroy any BFF-infested fruits. Furthermore, unnecessary movement of figs from infested sites is strongly discouraged.

(a) damage inside a fig;
(b) egg entry holes;
(c) fig fruit fly larvae
(d) figs that have fallen prematurely from the tree due to the larvae damage
(e) larvae showing itself from entry hole
(f) fly pupa
Photo source: unknown

Genetic Mutations in Fruit: Chimeras

Sonia Rios

Chimeras are a result of a cell genetic mutation that happen spontaneous or caused by irradiation or treatment with chemicals. They can occur on the leaves or the actual fruit itself. Leaf - the mutation produces variegated leaves, misshapen leaves, or leaves that are completely white. May also produce multiple bud growth resulting in a witches' broom symptom. Restricted to one section of a tree. Fruit, overall fruit appearance can be changed, or sections of the rind can appear striped and/or green.

If the cell that mutates is located in a meristem, all other cells that are produced by cell division from the mutated cell will. Also be mutated. With that in mind, leaves or fruit are said to be a chimera when cells of more than one genotype are found growing adjacent to each other in the tissues of the plant. A chimera can produce an improved crop: some of today's cultivars were propagated from chimeras, such as the variegated pink lemon. Cyanide application during flower bud formation was found to increase the frequency of ridged sectors (Sinclair and Lindgren, 1943), however the effect of environmental factors on the production of citrus fruit chimeras is unknown.

Usually sports are of inferior quality and should be avoided as propagation material. Prune sports that obstruct normal growth or interfere with harvest and are considered a negative attribute for packers and consumers.

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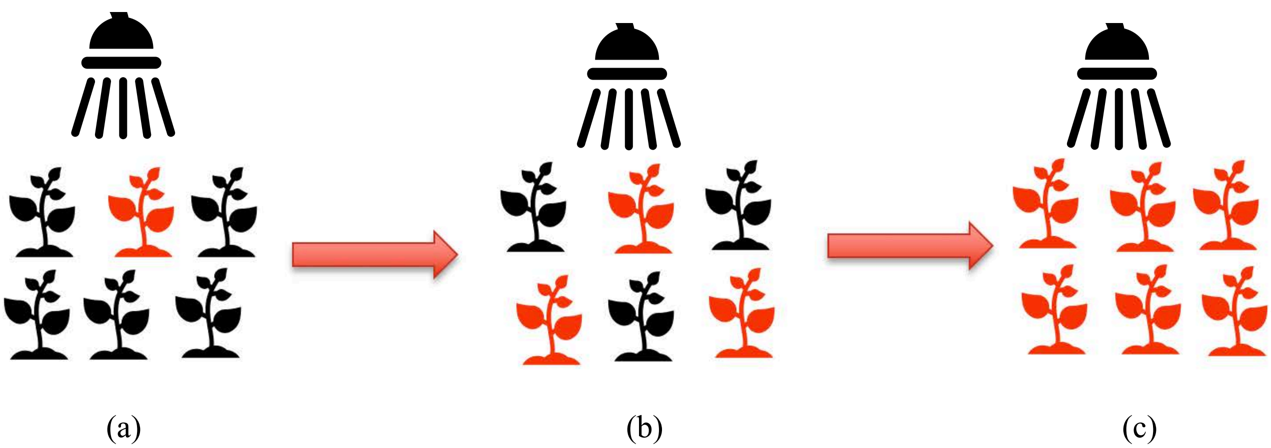
What is Pesticide Resistance and How Does it Happen?

Sonia Rios

An individual organism's genes determine its physical and behavioral traits. When individuals reproduce, they pass along unique combinations of genes to their offspring. Different environments favor individuals with different physical and behavioral traits (Hawkins et. al. 2019). Individuals with genes that improve their survival will be more likely to pass along these genes compared to the rest of the population. The mix of genes in a population is called the gene pool. The composition of the gene pool continually changes over time through a process called natural selection.
Pesticides are substances that control various types of pests, such as weeds, harmful insects, and disease-causing organisms like bacteria and fungi. Pesticides oftentimes are the most effective and efficient pest control tools available (Maino et. al. 1997). Repeated use of the same class of pesticides to control a pest can cause undesirable changes in the gene pool of a pest leading to another form of artificial selection, pesticide resistance (Figure 1). When a pesticide is first used, a small proportion of the pest population may survive exposure to the material due to their distinct genetic makeup.

Figure 1. Using the same mode of action can create pesticide resistance.



a) By natural selection there is always a few plants that will be automatically resistant to the pesticide in use, that one biotype survives the first application.
b) When one uses the same chemical (mode of action) over and over again, it gives that one plant the opportunity to multiply and spread those resistance genes.
c) It takes anywhere from 5-10 years for an entire population to become completely resistant to the same chemical (mode of action).

These individuals pass along the genes for resistance to the next generation. Subsequent uses of the pesticide increase the proportion of less-susceptible individuals in the population. Through this process of selection, the population gradually develops resistance to the pesticide (Comins 1977).

Growers can help delay the development of resistance by applying pesticides only when they are needed, by rotating between different chemical classes, and by using rates of pesticides within the labeled range (Jutsum et. al 1998). Integrating non-chemical approaches such as pheromone mating disruption and cultural controls can also help delay resistance. Resistance to pesticides is a serious, and growing, problem. Worldwide, more than 600 species of pests have developed some level of pesticide resistance. If resistance to a particular pesticide or "family" of pesticides evolves, these products can no longer be effectively used thereby reducing the options available for pest management. With few new pesticides (new modes of action) in the development pipeline, pesticide users must do all they can to extend the useful life of the products currently available.

Below: An example of pesticide (herbicide) resistance. One surviving biotype amongst all dead susceptible biotypes. Photo: Sonia Rios

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ANNOUNCMENTS

2- Day San Diego County South American Palm Weevil Symposium – FREE

San Diego County Symposium Day 1: South American Palm Weevil, a new invasive pest of palms

This online webinar is Day 1 of a two-part series on the South American Palm Weevil. The South American Palm Weevil (SAPW) has become well established in San Diego county, where it is causing havoc among homeowners and landscape professionals. While it prefers Canary Island Palms, it will infest a variety of other palm species, including dates. This session will focus on this new invasive pest of palms.

This webinar will begin at 8:00 AM and is expected to end at 10:45 AM with a break in the middle. Two DPR CE units (other), two CCA CE units (IPM), and two WC-ISA units were **requested**.

Day 1, Register: https://ucanr.zoom.us/webinar/register/WN_hoK-tEpzTXiM4LtCsWpKug

San Diego County Symposium Day 2: South American Palm Weevil - County updates and control options
Sep 22, 2021 08:00 AM PST

This online webinar is Day 2 of a two-part series on the South American Palm Weevil. This session will focus on updates in San Diego County, Orange County, and in the date palm industry. Monitoring and management will also be discussed.

This webinar will begin at 8:00 AM and is expected to end at 11:00 AM with a break in the middle. 2.5 DPR CE units (other), 2.5 CCA CE units (IPM), and 2.5 WC-ISA units were requested.

Day 2, Register: https://ucanr.zoom.us/webinar/register/WN_NN8IUQBWS46_9vKktuy24Q

- Just as a reminder, here are the requirements for receiving the CEUs:
    - register separately with your own name and email address and log in from your own device
    - participate in the entire session
    - respond to the polls/knowledge checks as they come up (if polls don't work on your device use chat to submit your answers),
    - respond to the final survey at the end of the webinar and include your name, license number, and email address.

Sponsored by: Western IPM

2022 Avocado Grower Seminar Series

The planning committee is currently making some last-minute adjustments to next year's schedule, which will be online soon.

University of California
Agriculture and Natural Resources

CALIFORNIA AVOCADO COMMISSION

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