Topics in Subtropics Newsletter

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News from the Subtropical Tree Crop Farm Advisors in California

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TOPICS IN THIS ISSUE

AUTHORS

- **Greg W. Douhan**, UCCE Area Citrus Advisor for Tulare, Fresno, and Madera Counties, Tulare.
- **Nguyen A. Dzung**, Director of the Institute of Biotechnology & Environment, Tay Nguyen University, Vietnam.
- **Akif Eskalen,** UCCE Specialist Subtropical Crops, University of California Riverside.
- **Ben Faber,** UCCE Subtropical Crop Advisor for Ventura and Santa Barbara Counties, Ventura.
- **Beth Grafton-Cardwell**, UCCE IPM Specialist and Research Entomologist, Director of the Lindcove Center, Exeter.
- **Craig E. Kallsen**, UCCE Fruit and Nut Crop Advisor for Kern County, Bakersfield.
- **Dani Lightle**, UCCE Orchard System Advisor, Glenn, Butte & Tehama Counties.
- **Joey Mayorquin**, Post-Doctoral Researcher, University of California, Riverside.
- **Mohamed Nouri**, Assistant Specialist, University of California, Davis.
- **Sonia Rios**, UCCE Subtropical Crop Advisor for Riverside and San Diego Counties, Moreno Valley.
- **Philippe Rolshausen**, UCCE Specialist Subtropical Crops, University of California, Riverside.
- **Florent Trouillas**, UCCE Specialist Fruit and Nut Crops, University of California, Davis.

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FARM ADVISORS AND SPECIALISTS

Greg Douhan – Area Citrus Advisor, Tulare, Fresno, Madera
Phone: 559-684-3312
Email: gdouhan@ucanr.edu
Website: http://cetulare.ucanr.edu

Akif Eskalen – Subtropical Extension Pathologist
UC Riverside
Phone: (951) 827-3499
Email: akif.eskalen@ucr.edu
Website: http://facultydirectory.ucr.edu

Ben Faber – Subtropical Horticulture, Ventura/Santa Barbara
Phone: (805) 645-1462
Email: bafaber@ucdavis.edu
Website: http://ceventura.ucdavis.edu

Elizabeth Fichtner – Orchard Systems, Tulare
Phone: (559) 684-3310
Email: ejfichtner@ucanr.edu
Website: http://cetulare.ucanr.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

A Taste of Coffee

Dr. Philippe Rolshausen
philrols@ucr.edu
University of California, Riverside

Dr. Nguyen Anh Dzung
nadzungtaynguyenuni@yahoo.com.vn
Tay Nguyen University, Vietnam

Coffee is one of the top 3 most traded commodities in the world. About 12 billion pounds of coffee are consumed each year worldwide. In the US, coffee consumption has been steadily increasing and today Americans average about 4 cups of coffee per day. The US coffee market is worth over $75 billion with 34,000 shops generating $21 billion in retail revenue. The average American consumer is becoming increasingly educated about coffee and many have become connoisseur. Producing dry coffee beans (Fig.1 #4) is in many ways similar to wine making because coffee can reflect the character of a variety. After harvest, the berries (a.k.a. cherry; Fig.1 #1) are fermented. During this process yeasts break down the mucilage (i.e., the flesh around the bean). The parchment (Fig.1 #2) that remains around the green beans (Fig.1 #3) is subsequently removed by dry milling before roasting. Also just like for wine, coffee aroma profile and organoleptic properties are graded and referred to as a cupping score, which has been developed by the Specialty Coffee Association, a nonprofit, membership-based organization that represents thousands of coffee professionals (https://sca.coffee).

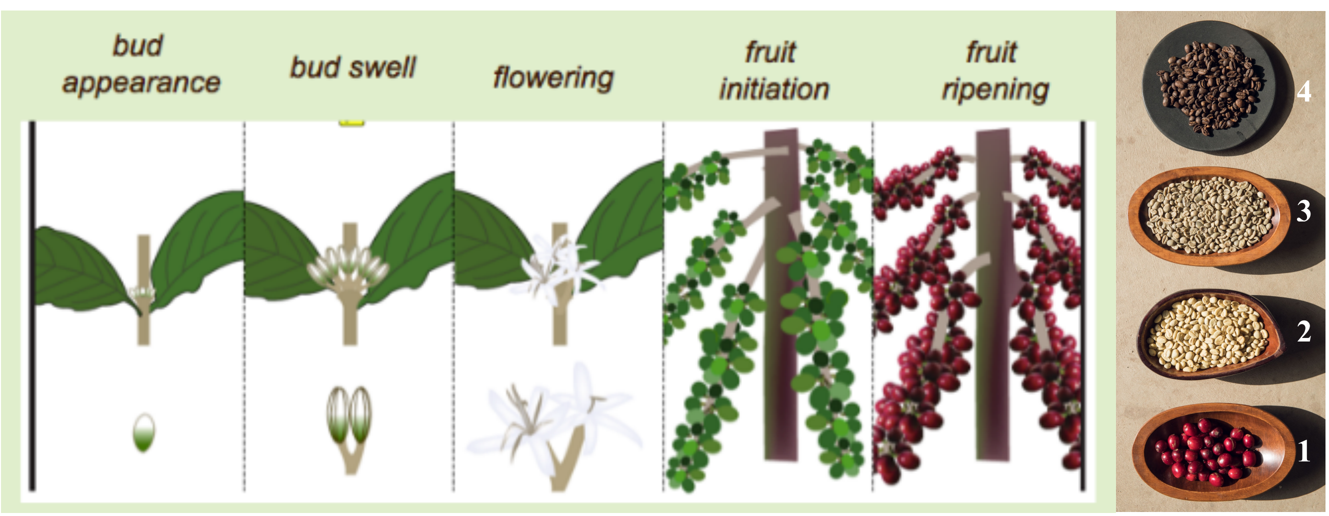

Figure 1 - Coffee flower and fruit stages

Figure 2 - Major diseases encountered in Vietnam coffee production. A-B: Root-Knot nematode. C: Colletotrichum. D: Insect borer. E: Rust

Coffee (*Rubiaceae* family) is concentrated in the tropics and subtropics. The genus *Coffea* has over 60 species of which *C. canephora* (a.k.a. Robusta) and *C. Arabica* are the most common ones. Arabica coffee is praised for its excellent cupping quality and consumers demand is high. The US coffee market is dominantly Arabica and imports mainly from Brazil but other importing markets include Asia. I had the privilege to be invited by Dr. Dzung Anh Nguyen at Tay Nguyen University in Dak Lak province, Central highland region of Vietnam, to educate myself about the art of growing coffee and its challenges. Vietnam produces 3 billion lbs of coffee beans annually on 1.5 million acres (95% Robusta and 5% Arabica) and exports about 0.4 billion lbs of coffee to the US, although its main market streams are Europe, Japan and Korea. This industry is valued at $4 billions, with over $3 billions to export. In Vietnam, Arabica yields about 1-2 tons per Ha at $4,000 per ton, whereas Robusta yield twice as much for half the price. France introduced coffee production in Vietnam around 1915. The culture of coffee is now anchored deep in this region and a corner stone of the local economy. The elevation of the central highland in Vietnam ranges from 1,500 to 6,000 feet. Above 3,000 feet, Arabica is grown and Robusta below that line. The acidic soil, rain pattern and high elevation provide a unique environment for Arabica coffee plants. In addition, high elevation limits the incidence and severity of coffee rust. This fungal disease is a major limiting factor to coffee production worldwide. Robusta is known to be more tolerant to the disease and can be grown at lower elevation where disease pressure is higher. Besides rust, coffee berry borer, nematodes and soil borne fungal pathogens can cause devastating losses in coffee growing regions (Fig.2). Invasive pests and diseases, global warning, water availability and quality are key variables that need to be factored into market projection growth and availability of the supply chain. According to the Australia's Climate Institute's, hotter weather and changes in rainfall patterns are projected to cut the area suitable for coffee in half by 2050.

In the US, Hawaii is the leading coffee producer with 38 million lbs of cherry on 7,000 bearing acres in 2017 (USDA Statistics). As a reference point, a pound of Kona coffee cost about $35-50 at a retail store. In California coffee is not a commodity but a niche market that produces rare and specialty coffee. This is the fastest growing segment of the US coffee market and it has been valued at over $40 billion. In the past decade, California has become a fertile region for coffee. There was currently about 30-farms and 30,000 trees but with projections of 60,000 in this upcoming year. Research led at UC Davis has provided valuable science –based information (including the Arabica genome sequencing) to coffee production under our climate. In collaboration with the UC Cooperative Extension and specifically Mark Gaskell, practical guidelines have been developed to optimize coffee production in our region that includes selection of adapted varieties, plant nutrition and irrigation needs http://ceventura.ucanr.edu/Com_Ag/Subtropical/Minor_Subtropicals/Coffee_/

Evidence suggests that the mesoclimate of southern California (i.e., where avocado is grown) provides enough heat and sunlight units to grow Arabica. California also offers the unique advantage of having no serious pests or diseases. Another major advantage is the use of automated and controlled irrigation because it has favored optimal fruit set and maturation. The only limiting factors can be alkaline soils and cold temperatures both of which can be managed by soil acidification (with sulfur and pit moss applications) and tree protection at the establishment of the orchard (Fig.3). Orchards of inter-planted coffees plants and avocado are common to provide shading. Likewise in the low lands of Vietnam robusta trees were inter-planted with pepper trees (Fig.3). This model also offers an economic advantage to maximize land surface and increasing profit. The California business model developed under the leadership of FRINJ coffee (www.frinjcoffee.com) and Good Land Organics (www.goodlandorganics.com) has boosted the local coffee industry. They have the ambitious goal to make California the world capital of specialty coffee. Adopting a science-guided approach has provided a solid foundation to make coffee farming lucrative. The start up costs for coffee production are the same as for avocado, but can be 3 times more profitable. In the current marketplace, specialty coffee price can range between $60-300 per pound (that's a $8-16 per cup!). The quality of FRINJ coffee has received international recognition for its quality (it ranked 27th for best coffee of 2015) and this storyline was highlighted in the New-York Times. (https://www.nytimes.com/2017/05/26/business/your-coffee-is-from-where-california.html).

Figure 3: Coffee farm in the US (left) and Vietnam (right). Coffee plants are inter-planted with avocado and pepper trees to provide shade for coffee and optimize land surface.

Colletotrichum Shoot Dieback: A New Disease of Citrus in California

Dr. Joey Mayorquin
joey.mayorquin@ucr.edu
Dr. Akif Eskalen
akif.eskalen@ucr.edu
University of California, Riverside

Dr. Mohamed Nouri
mnouri@ucdavis.edu
Dr. Florent Trouillas
flotrouillas@ucanr.edu
University of California, Davis

Figure 1: Citrus shoot dieback (top) and gummosis (bottom) caused by *Colletotrichum*.

A new disease of citrus has been found in the main growing regions of the Central Valley of California. The causal agents of this disease were identified as species of *Colletotrichum,* which are well-known pathogens of citrus and other crops causing anthracnose diseases. Several growers and nurserymen in various orchards in the Central Valley first noticed the disease in 2013. Symptoms include leaf chlorosis, crown thinning, gumming on twigs and shoots dieback, and in severe cases, death of young trees. The most characteristic symptoms of this disease are the gum pockets, which appear on young shoots either alone or in clusters and the dieback of twigs and shoots (Fig.1). Field observations indicate that symptoms initially appear during the early summer months and continue to express until the early fall. These symptoms were primarily reported from clementine, mandarin, and navel orange varieties. In order to determine the main cause of this disease, field surveys were conducted in several orchards throughout the Central Valley. Isolations from symptomatic plant samples frequently yielded *Colletotrichum* species. Morphological and molecular phylogenetic studies allowed the identification of two distinct species of *Colletotrichum* (*Colletotrichum karstii* and *Colletotrichum gloeosporioides*) associated with twig and shoot dieback. Interestingly, these *Colletotrichum* species were also isolated from cankers in larger branches. Although *C. gloeosporioides* is known to cause anthracnose on citrus, a post-harvest disease causing fruit decay, it has not been reported to cause shoot dieback. *C. karstii* however has not been reported previously from citrus in California and our research team is currently conducting field and greenhouse studies to determine the pathogenicity of this species in citrus. At present, it is unclear how widespread this disease is in California orchards or how many citrus varieties are susceptible to this disease. Pest control advisors are monitoring citrus trees for the presence of the disease in the Central Valley (particularly clementine, mandarin, and navel varieties) during the early summer months. Continuing research led by Dr. Akif Eskalen in collaboration with Dr. Florent Trouillas is focused on further understanding the biology of the fungal pathogens as well as factors influencing disease expression in order to develop management strategies against this emerging disease.

Successfully Irrigating Potted Trees

Dani Lightle
dmlightle@ucanr.edu
Cooperative Extension Glenn County

Establishing an orchard with containerized (potted) trees is now common, especially as nurseries continue to move towards greater potted tree production. These trees offer benefits to growers: the flexibility to plant almost year round, as well as reduced incidences with root injuries and subsequent crown gall infection. However, they also have their challenges: potted trees can be a bit more finicky with initial planting and establishment. Potted walnuts also need to be field grafted or budded, which has resulted in delays in production for some blocks if bud take is low.

Generally, when I am working with growers on a problem related to potted-tree establishment, the cause is an issue with irrigation. Typically, the trees will have very little new growth, or sometimes buds have hardly pushed at all. The trees will look this way across the orchard, as opposed to localized patches. The trees look – and are – extremely water stressed. The problem is not that the grower isn't irrigating – often, they are irrigating a large amount relative to the size of the trees. Instead, the problem is that the applied water is not actually accessible by the tree. This is a result of the soil boundary between the orchard soil and the tree's potting soil. Water moves two ways in soil: laterally (side to side) and downward. There are two forces at play. The first you can probably guess: gravitational pull, which moves the water downward. Water will move downwards more quickly in a sandy soil with large pore spaces than in clayey soils with small pore spaces (loamy soils have an intermediate pore size). The second force is capillary action, which is responsible for the lateral movement of water through the soil. Capillary action describes the phenomenon of liquids moving through narrow spaces, seemingly on their own, even against gravity. You have probably seen capillary action before – it's the force responsible for the entire string on your tea bag getting wet, even though it is hanging out of your mug. Capillary action is stronger (and thus water moves further) in substrates that have small pore spaces (clay soils) than in substrates that have large pore spaces (sandy soils). Figure 1 shows a typical wetting pattern in clay soils versus sandy soils. The downward versus lateral movement in response to pore size is evident in the shape of the wetting pattern.

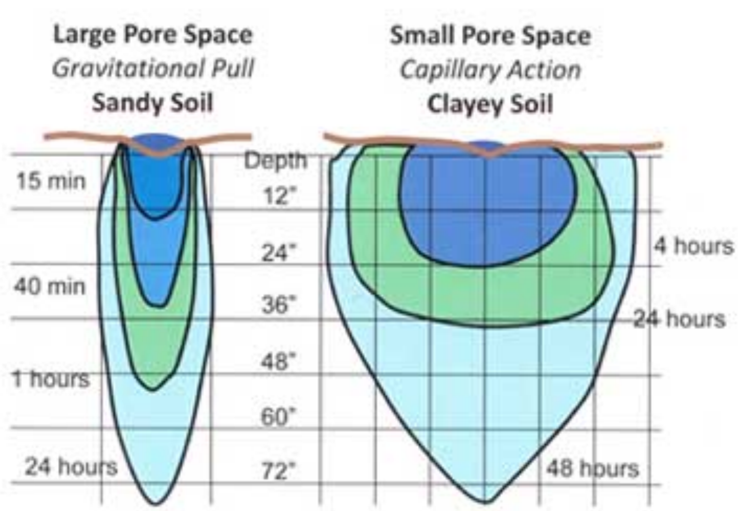

Figure 1. Typical wetting patterns over time in sandy versus clay soils. Figure courtesy Colorado State Extension.

So how do these wetting patterns relate to potted trees? When you plant a potted tree in your orchard, it has a different substrate – some mix of peat and vermiculite – than the rest of your soil, which is more likely some mix of clay, loam, and/or sand (depending on your location). The change in soil texture and pore size inhibits water movement from one soil type to another. The sequence of photos in Figure 2 demonstrates this phenomenon. I set up a mock orchard condition with soil (Tehama series silty loam) next to a potted tree (potting soil) in a ½ inch wide frame. I then slowly added water, similar to a drip emitter, approximately 4 inches away from the potting soil in the 'orchard' soil. As you can see, the water moves both down (gravitational pull) as well as laterally (capillary action). The capillary action is strong enough in the orchard soil that the water moves laterally underneath the potting soil (Fig.2D). What the water does not do is move into and wet the potting soil. Since the potting soil is not below the orchard soil, gravity will not move water to the potting soil. Similarly, the capillary action is not strong enough – the pore sizes in the potting soil are considerably larger than the pore sizes in the orchard soil.

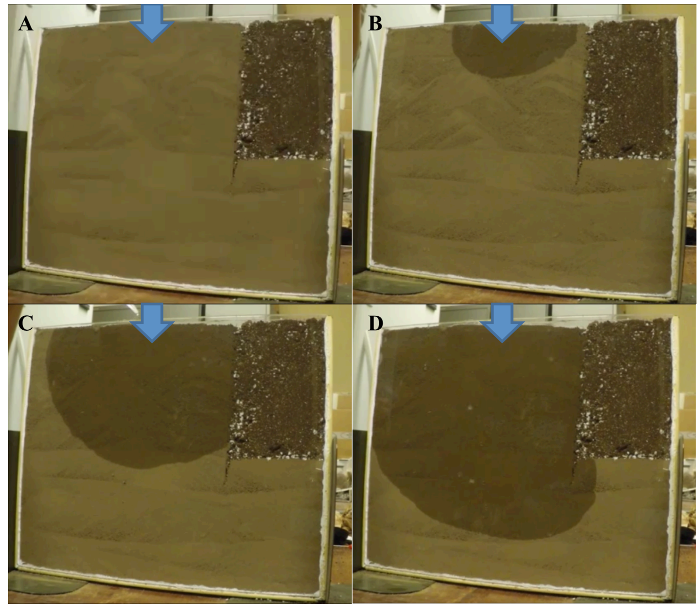

Figure 2. Movement of water in soil. Water was applied 4 inches from the potting soil (blue arrow). Time elapsed: 51 min.

Ok, let's go back to our problem orchards: newly planted, water stressed potted trees. I mentioned that these orchards are often irrigated with much more water than is required by the trees. However, in these orchards, the emitter was not located in an optimal location. To wet the potting soil, the drip emitter MUST be located right at the base of the tree. Similarly, a microsprinkler (ideally with the downward facing cap) needs to be irrigating the potting soil/root ball directly. If you are planting potted trees in an orchard with solid set, furrow, or flood irrigation, I suggest you re-think this plan carefully. Water needs to be applied frequently and in a very specific location. This can be done (though highly inefficiently) with a solid set system. It is virtually impossible with a furrow or flood irrigated orchard. If your orchard relies on any of these three irrigation types, I recommend installing a temporary drip line for irrigating the trees during the original establishment phase, before relying on your primary irrigation system. My next recommendation is that you frequently check your potted trees to ensure that the potting soil stays wet. Check the potting soil – not the soil somewhere else in the tree row or mound – before, after, and between irrigation sets to ensure that it is getting water and maintaining adequate moisture. The best way to do this is with a small trowel and your hands. Water will need to be applied at the base of the tree until the tree roots grow from beyond the potting soil and into your orchard soil substrate. The time for this to happen will vary depending on factors such as temperature, but it should take roughly a month. Potted trees have some other differences from their bare root counterparts. However, far and away the biggest and most critical challenge is irrigation. Spend the time to get it right – your orchard should respond accordingly.

An Update on Huanglongbing Disease of Citrus in California

Dr. Greg Douhan
gdouhan@ucanr.edu
Cooperative Extension Tulare County

Dr. Ben Faber
bafaber@ucanr.edu
Cooperative Extension Ventura County

Sonia Rios
sirios@ucanr.edu
Cooperative Extension Riverside County

Craig Kallsen
cekallsen@ucanr.edu
Cooperative Extension Kern County

Dr. Elizabeth Grafton-Cardwell
eegraftongcardwell@ucanr.edu
Director of Lindcove Research and Extension Center, Exeter

Many pests and pathogens can affect the value of citrus production but only a few are able to inflict severe damage, reduce yield, and/or kill citrus trees. For California and some other citrus producing areas, Huanglongbing (HLB) is the most severe disease issue possible and it will have a significant impact on citrus production when it invades commercial citrus areas. In North America, the bacterium that causes the disease is *Candidatus* Liberibacter asiaticus (CLas) and it is vectored by the insect *Diaphorina citri*, referred to as the Asian citrus psyllid (ACP). Once an infection occurs via grafting from infected plant material or by HLB positive psyllids, the bacterium will reproduce within the sugar conducting tissues (phloem) of the infected citrus plant. Initially, only portions of the tree will show symptoms, but eventually the infection will spread and lead to the decline and death of the tree. Currently, there is no effective way to directly control the disease but only to provide various inputs that will prolong production.

Table 1. HLB and ACP finds in Southern California (April 2018; https://citrusinsider.org/maps/)

County	City	No. of Sites	No. of Trees	No. of ACP
Orange	Anaheim	136	193	64
	La Habra	1	1	0
	Fullerton	2	1	2
	Garden Grove	92	121	38
	Santa Ana	4	3	3
	Westminster	8	9	1
	Yorba Linda	1	0	1
Los Angeles	San Gabriel	49	61	6
	Cerritos	3	2	2
	Hacienda Heights	2	2	1
	La Puente	1	0	1
	Pico Rivera	74	87	35
	Rosemead	8	7	1
	Whittier	56	76	6
	Norwalk	3	1	2
Riverside	Riverside	4	3	3
San Bernardino	San Bernardino	1	0	1
	Totals	**445**	**567**	**167**

Just over a decade ago, HLB was confirmed in the Americas, originally in São Paulo State, Brazil in 2004 and the State of Florida, USA in 2005. The disease spread rapidly in both São Paulo and Florida, causing significant economic losses as it has in Asia for many years and has since spread to other States in the USA. The first report of ACP in California was in 2008 and the first HLB infected tree was reported in 2012 from a homeowner's tree found in Hacienda Heights, Los Angeles County. The infected tree was quickly destroyed via action taken by the California Department of Food and Agriculture (CDFA). Since this first detection, both HLB positive trees and psyllids have been detected in 4 Southern California counties at an alarming rate (Table 1). It should also be noted that most of the infected trees have been identified in the past two years but there have still been no HLB positive trees been found in commercial citrus production areas in California thus far. Therefore, all individuals involved in the citrus industry should be on the look out for symptoms of HLB and the presence of ACP within commercial groves.

HLB symptoms: Usually, the first visible symptoms observed for HLB are asymmetrical yellowing of leaves, which is often referred to as a 'blotchy mottle' symptom of the leaves (Fig.1A). This blotchy mottle pattern is a random pattern of yellowing or chlorosis on the leaves that are usually not the same on both sides of the leaves as delimitated by the main leave vein. Mottling is also most frequently found on newly mature leaves (hardened-off), but often fades with leaf age. However, these symptoms can also be sometimes confused with some nutrient deficiencies. Most nutrient deficiencies will usually produce more uniform mottling or chlorotic symptoms (Fig.1B). Some HLB-infected leaves may also produce yellow veins, vein corking, or green island symptoms (Fig.1C). Sometimes only segments of the tree will show chlorotic symptoms often referred to as yellow shoots (Fig.1D). Eventually the trees will weaken, begin to dieback and decline overtime (Fig.1E). Infected trees eventually produce fruit that are sour tasting, unevenly colored, and are often lopsided (Fig.1F-G). Be forewarned, that if you see visible symptoms, the tree has been infected for months if not years, and it is likely that nearby trees are also infected.

Curtailing the spread of HLB and ACP The first line of defense against HLB is to keep ACP under control in Southern California and coastal citrus growing regions and continue eradication efforts in the San Joaquin Valley (SJV). However, this is a difficult scenario in Southern California, since the insect is common throughout this region. Its presence in residential areas hampers control measures because there is always a 'source' of more insects to move back into commercial production areas. It is important for growers in these regions to treat their orchards in a coordinated fashion in the spring and fall with ACP-effective insecticides as directed by their Task Force or Pest Control District. Within the SJV, the counties of Kern and to a lesser extent Tulare had frequent finds of ACP in 2016, but a lot of effort went into reducing population levels of the insect through pesticide applications and finds decreased in 2017. However, the insect is continuing to appear periodically in the SJV, so growers must be diligent to scout their fields. For monitoring, two strategies are to walk orchard perimeters and examine new flushes of growth to look for the nymphal stage or do tap sampling for adults. In southern California, it is important to reduce populations below 0.5 nymphs per flush. When looking for psyllids, signs of adults, eggs, or nymphs producing waxy tubules can be identified, as well as possible damage on developing leaves (Fig.1H). Detailed information regarding tap sampling, including a video demonstration, can be found at the University of California ANR website (http://ucanr.edu/sites/acp/).

Biological control tactics were also initiated in 2010 to help control ACP populations within residential areas, since spraying of pesticides was not easily accomplished. The parasitic wasp, *Tamaraxia radiata*, was collected by UC Riverside Entomologist Mark Hoddle from Punjab, Pakistan, because it was endemic to the native range of ACP and was thought that a similar environment to California would make it a potential candidate to fight this insect. In addition to the *T. radiata*, an additional parasitoid, *Diaphorencyrtus aligarhensis*, was also reared and released. Both species kill the ACP insects through a combination of parasitism and host feeding. However, post-release monitoring in California has indicated that ACP parasitism by *T. radiata* is low to moderate and varies greatly across locations, seasons, and years. Moreover, success of the parasitoids is also reduced when ants protect the psyllids from natural enemies.

Both monitoring and management of ACP are extremely important concepts to slow the threat of HLB. Eradication approaches should be used in areas where the insect is relatively rare (SJV) whereas growers need to continue to conduct periodic coordinated treatments in areas where ACP is well established (Southern and coastal California). In the latter case, growers need to focus on reducing overwintering adults and protecting new flushes from egg-laying by the insect. The fall months are especially important as that is when the populations can build to high numbers. In the Ventura, San Bernardino and Riverside areas, where trees flush frequently and psyllid populations are high, two fall treatments are needed to control psyllids. Because the psyllid prefers the edges of orchards, if sampling indicates the center of the orchard is free of psyllids, then one of the fall treatments could be a perimeter only spray. It should also be noted that not all insecticides are equally effective against ACP. More information can be found at the UCCE extension website (http://ucanr.edu/sites/acp/) but some of the key points are:

- Focus on overwintering adults and protecting new flush
- Broad spectrum, long residual insecticides are especially important in the fall when ACP populations grow fast
- Two fall treatments are needed in regions where the psyllid is abundant, though one of those treatments could be a perimeter spray if the center of the orchard is free of psyllids
- Rotate between chemistries to avoid selecting for resistance
- Use selective insecticides for the spring-summer treatments to allow natural enemies to survive and assist with control
- Be aware of Maximum Residue Limits to ensure exports

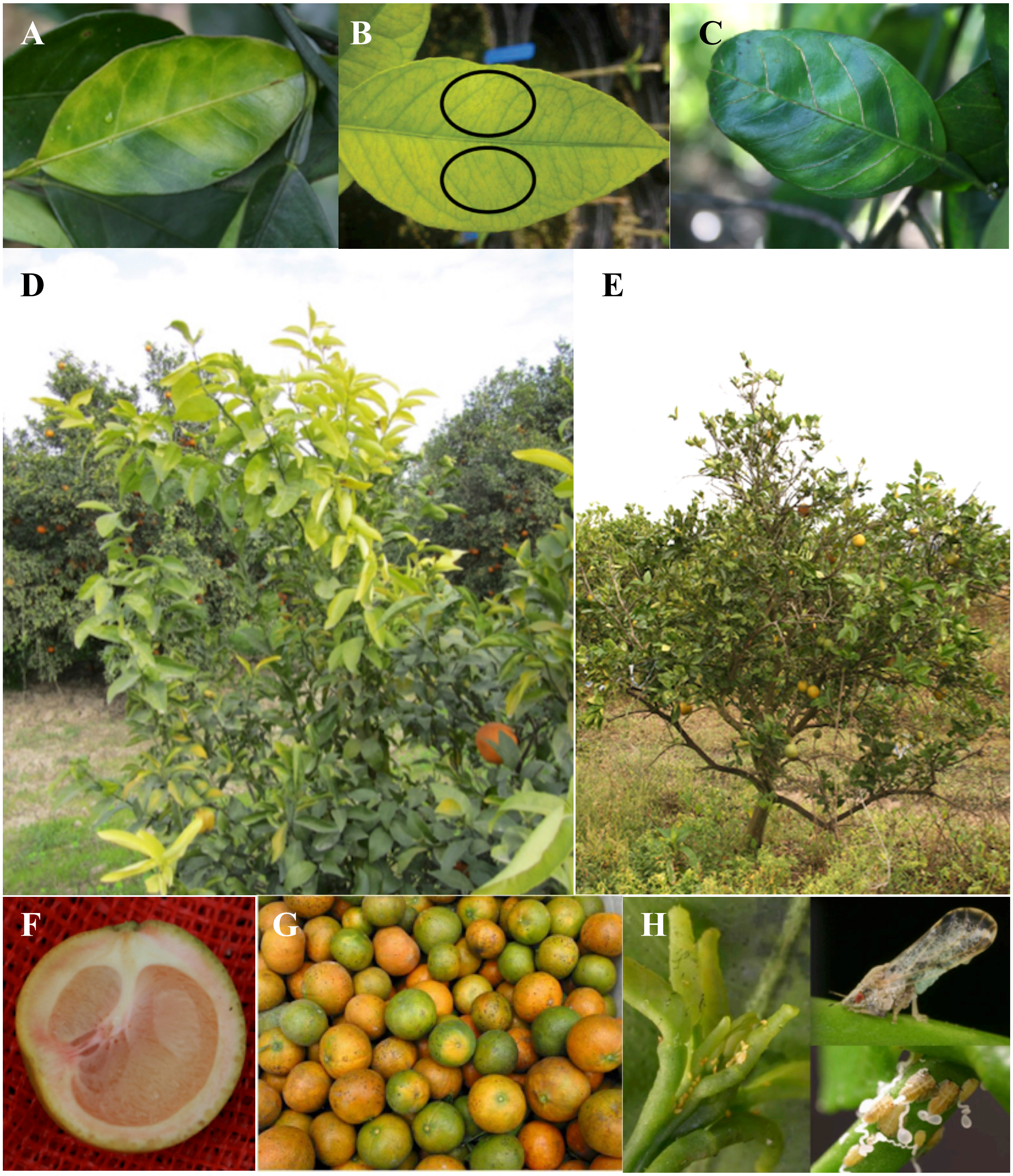

Figure 1: Citrus Huanglongbing disease symptoms, signs and vector. A: Blotchy mottle symptoms on leaves. B: Uniform and even mottling symptoms due to nutrient deficiencies. C: Corking veins and green island symptoms. D: Yellow-shoot symptoms. E: Declining citrus tree with thinning canopy and branch dieback. F: Lopsided fruit. G: Unevenly coloring fruit. H: ACP eggs on flush, adult insect, and nymphs producing waxy tubules.

Weather conditions may also influence the spread of ACP in California, especially in the SJV where more than 65% of the California citrus is produced. The SJV often has cold winters followed by hot dry summers that are not as conducive to support large populations of the vector. Similarly, the heat of the Coachella and Imperial valleys suppresses psyllids. Hot, dry summers also suppress the bacteria. In the SJV, growers use ACP-effective insecticides to control citrus thrips, katydids, citricola scale and Fuller rose beetle and these treatments help to keep ACP populations low. However, in-spite of this, ACP is expected to continue to spread in the SJV and the disease will appear eventually. In Southern inland and coastal California, ACP populations flourish. Environmental conditions and flushing host plants easily support nymphal development, thus the climate in these areas promotes ACP.

What does the future hold for California regarding ACP/HLB? On a positive note, there are some factors that may help limit the spread of HLB in California compared to Florida. The vector (ACP) thrives on young vegetative shoots. In Florida, there are constant flushes of newly developing tissues for the vector to continually develop year-round. In contrast, in California there are normally only two flush periods for most mature citrus, one in the spring that is always prominent and another in the fall that is not as prominent depending on the weather. The exception is coastal lemons that have continuous flushes that pose a significant challenge to deal with ACP/HLB, especially since residential and growing areas are more adjacent compared to other growing regions. Florida growers did not control ACP populations because they did not realize how severe HLB would be. In contrast, the CDFA has been monitoring ACP in California since 2008, sampling citrus and ACP for HLB around the state, setting up quarantine areas based on the findings, and have been working with Californians to inform them of the spread of the pest and disease. This program is funded by California citrus growers via the Citrus Pest and Disease Prevention Program (CPDPP). The grower/packer/nursery community as represented by the CPDPP in collaboration with various organizations including CDFA, USDA, University of California, the Citrus Research Board, California Citrus Mutual, Pest Control Districts, Task Forces and Pest Control Advisors have been at work to recommend coordinated spray programs to control ACP populations, assist with tree removal, conduct outreach programs, support research and develop recommendations for HLB management for the industry going forward

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Philippe Rolshausen, Editor

Topics in Subtropics