Topics in Subtropics Newsletter

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News from the Subtropical Tree Crop Farm Advisors in California

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- Preparing Frost Protection Measures
- The National Clean Plant Network, with emphasis on the National Clean Plant Network — Citrus
- Development of integrated pest management for huanglongbing (HLB) in Florida

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Preparing Frost Protection Measures
Dr. Ben Faber

Forecasts are for a mild La Nina which usually means low rainfall with cooler temperatures and lower relative humidities. All of which usually means more likely conditions for freeze events. The last major freezes in southern California were in 2007 and 2013. The last really big one was December 1990. Here's a fascinating history of major weather events in S. CA focusing on the San Diego area from NOAA

Frost Protection
In the United States, the economic losses due to frost damage exceed all other weather-related phenomena. Although the economic, environmental, and social impacts of frost damage are significant on a local and global scale, the information available to the public, particularly growers, on how to avoid plant damage is insufficient. As a result, the University of California Cooperative Extension created the following narrated training units to provide growers with the scientific principles behind frosts and to demonstrate various methods to prepare for frosts and avoid plant damage. The training unit titled "Passive Frost Protection" discusses the basic definition and types of frosts, how frosts relate to atmospheric conditions, and the preventative measures that are carried out prior to a frost event to avoid or minimize damage. The training units "Active Frost Protection: Water" and "Active Frost Protection: Wind Machines" discuss the energy and labor intensive processes carried out during a frost event. The final training unit, "Methods of Measuring Temperature", provides instructions for measuring various types of temperatures critical to frost monitoring and describes several of the frost alarm systems available to growers. These are both in English and Spanish versions.
The presentations below will run automatically on your computer, and include recorded audio.

- Active Frost Protection: Water
- Active Frost Protection: Wind Machines
- Passive Frost Protection
- Methods of Measuring Temperature

A Frost Primer

Definitions:

- Dry-bulb temperature: the temperature of the air as measured with a thermometer.
- Wet-bulb temperature: the temperature that the tree will likely sense due to evaporative cooling of the leaves.
- Dew point temperature: the air temperature required for condensation (dew or frost) to occur. This is an indication of the amount of humidity in the air. The higher the dew point, the lower the rate of cooling. As dew forms, the water releases heat (heat of condensation), and the temperature levels out.
- DEW POINT:
  - High dew point -- above 40 degrees
  - Moderate dew point -- between 25 - 40 degrees
  - Low dew point -- between 10 - 25 degrees
- "Cold night": any night at or below 32 degrees F.

- "Key stations": in the days of a "weather station" with at least a max/min thermometer and a thermograph in a white box facing north. Now with digital stations.
- Temperature inversion: an atmospheric layer in which temperature increases with altitude. High temperatures during the day promote the formation of the inversion.
- "Temperature ceiling": height to which heated air rises during orchard heating. The lower the ceiling, the stronger the inversion and a greater amount of heat can be obtained from wind machines and orchard heating.
- Radiation freeze (frost): local cooling due to rapid heat loss from plant and soil surfaces under clear skies and light or no wind conditions. Daytime temperatures are usually in the 45-55 degree range which causes the formation of a nighttime inversion. Any significant breeze will cause temperatures to rise due to mixing of the inversion.
- Advective freeze: cooling of a wide area by dry polar air. Typically, the temperature is at or below 32 degrees for 2 or more days. The temperature ceiling is high or non-existent. This was what we got in the devastating freeze of December 1990.
- 1 gram of water = 1 calorie/degree of temperature change (C)
  1 gram of water = 79 calories released on freezing
  1 gram of water = 607 calories consumed when evaporated

Gauging Wind Speed

Effect of air movement	**Wind force (mph)**	**Terms used in forecasts**
Calm; smoke rises vertically	less than 1	
Wind direction shown by smoke drift	1 - 3	light
Wind felt on face, leaves rustle	4 - 7	
Leaves and small twigs in constant motion	8 - 12	gentle
Raises dust and loose paper; small branches move	13 - 18	moderate
Small trees in leaf begin to sway	19 - 24	fresh
Large branches in motion	25 - 31	
Whole trees in motion	32 - 38	strong
Breaks twigs and weak branches	39 - 54	gale

Irrigation in a Freeze

Confronted with approaching freezing conditions a grower has several options to mitigate the potential cold damage. There are foliar sprays like copper that can reduce the incidence and need to be applied several weeks in advance of cold. There are orchard heaters that are still allowed in some growing areas but tend to be expensive to run due to fuel costs. There are wind machines that are capable, but less effective on avocado hillsides that have natural air movement. Then there is irrigation.

Of course you need healthy, well-watered trees to protect, otherwise, it is probably not worth the effort. And you need water that is dispersed in the air. Drip is much reduced in efficacy compared to

microsprinklers and much less than high pressure overhead sprinklers. And you need water volumes that can be used continuously over the protected area during the freezing period.
Using irrigation water in frost control is a delicate balance among different physical characteristics of water. When it freezes, from a liquid state to the solid ice state, heat is released. More than what is actually making up the temperature of the liquid water. But then, in its liquid state, it starts evaporating turning to a gas which cools the surroundings. Heat from liquid to solid and cooling from liquid to gas. There's another property of water which is that it conducts heat really well, better than solid earth. So, wet soil heats up better from the daytime sun than a dry one.

So, you want to make sure the soil is moist during the day to soak up the heat. Then, you don't want water being applied after sunset to avoid evaporative cooling. Then when the trigger temperature for freezing occurs, the system should be run continuously so that heat is released during the freezing cycle. If you stop the water, then evaporative cooling kicks in and it could be colder than it would be if you had not run the water. And sometimes the emitters freeze up if they are turned off, and then they don't function when you try to come back around.

So, with that, you need to decide how much water you can run continuously in a given area. So, what is the coldest spot, and can you cover that area continuously for the cold period? Or the reverse is, if you know the cold area is going to get really cold and it may not make it through the cold even with irrigation, what is the area you want to protect that you know can be helped with irrigation? The water needs to run continuously. You don't want to be turning it on and off in order to roll it over to other irrigation blocks. When the water is turned off, the air starts cooling from evaporation. So decide how much area can be watered with the given volume.

Knowing all this you start watching for the cold with low temperatures that show 32 or lower. Older trees with canopies to the ground can handle more cold than young trees with little canopy to retain heat. Watch for the dew point. If it shows something much below 32, like 25, that means the air is dry and there will be a rapid temperature drop once temperatures start heading for the low temperature. So, you are forewarned. Get water on to the grove to make sure the trees are adequately hydrated. Then a couple of days before the freeze event, make sure the surface soil is wetted during the day to take advantage of daytime heat, but make sure the water is off before sunset. Then when the big night hits, when temperatures hit a trigger temperature like 33 or 34, you should start the water. You want to have the system going before it drops below 32. Run the system until sunrise, and then you can most likely shut down. And wait for the next night and follow the same drill. We often will have two to three nights in a row that need protection.

Frost Protection Spray Trials

The use of foliar nutrients as frost protectants has been promoted for years. Research published by Steve Lindow at UC Berkeley explained that certain naturally occurring bacteria ,such as *Pseudomonas syringae* and *Erwinia herbicola* act as nucleating agents for ice formation. The presence of these ice-nucleation-active bacteria results in the formation of ice crystals in plant tissue at temperatures several degrees higher than in their absence. When water in plant cells freezes, it expands and ruptures the cell walls, leading to cell necrosis. The bacteria can be killed or prevented from acting as nucleating agents, thus providing several degrees of frost protection.

This discovery provided a plausible explanation for the previously observed positive effects of foliar sprays on freeze tolerance. While the mechanism can be explained, there is no general agreement on which chemicals are most effective in controlling the ice-nucleating bacteria. These products need to be applied early enough to remove the ice-nucleating bacteria, but not so early that they have a chance to return.

Several specially formulated products are commercially available, but in controlled tests these have generally not given better results than copper-based fungicides or micronutrient mixtures. Certain urea-based products, antibiotics, anti-transpirants, and surfactants have also claimed to be effective.
At issue is not only these surface-dwelling bacteria, but also the age of the tree, development of the canopy, the length degree of the freeze event, the health of the tree, nutritional and irrigation status and when the event occurs. Trees that gradually go into a quiescent stage of winter, are better able to sustain cold stress than those that are hit early on before they start shutting down for winter. Trees develop a cold-hardiness. And plant growth regulators, those both internal and external, play a roll.
I have run trials where I have seen incredible effects after using a certain type of kelp. Kelp has all kinds of ingredients, and they vary depending on what part of the ocean, what species, when it is harvested and how it is processed. When trying to reproduce the effect I had initially seen with the same kelp or other sources, I was not able to get the same effect. This was in three separate trials. It's hard to reproduce the same conditions or the right time of application. The river never runs the same.
Foliar sprays are capable of influencing frost tolerance. Copper and zinc have most consistently shown a positive effect. And the most vulnerable would be small trees that are the easiest to spray. It's a relatively inexpensive treatment and depending on the mate4rial, can be used in both conventional and organic orchards.

You can read about our four-year evaluation of materials for reducing frost damage. There were some positive results, but they are also equivocal -
https://ceventura.ucanr.edu/Com_Ag/Subtropical/Publications/Frost/Foliar_Sprays_for_Frost_Protection_of_Young_Citrus_and_Avocado_-_1995_/

Fall and Winter is NOT the Time to Prune Avocados

In the past avocados were rarely pruned. In fact, if the trees got very big, growers would stump them down to 3-4 feet and then let them regrow. This would often be a disaster, since the trees rapidly grew to stupendous sizes again. They also might regrow then suddenly collapse, because all that regrowth was coming at the expense of energy being sent to the roots. If the roots were compromised by root rot, they would then not have the energy to fend off the disease. So, by bringing the canopy into balance with a sick root system that was continuing to die and was not being fed by a big canopy, the root death would accelerate and when the canopy and root system became imbalanced again, the whole canopy would collapse, and the tree would die.

Also, this wild regrowth was wild and hard to manage. The adage of "prune avocado trees cautiously" was heard round the avocado community and as a result many growers would not do anything. The trees growing larger and larger and larger with the fruiting canopy going higher and higher and higher and picking costs and liability going up. Tree thinning was practiced, where every other tree would be removed so that light could penetrate into the orchard, encouraging more fruit production and slowing tree growth. But they would still grow, and another thinning would be needed. The original commercial 'Hass' orchard in Carpinteria started out in 1954 with 140 trees and 40 years later was down to 17 trees and was still productive, but they were monsters that were finally felled by root rot.

Many commercial avocados are now routinely pruned to keep the trees short, so that harvesting costs and other tree maintenance expenses are reduced. Also, more light shines into the trees, so that more fruit is borne on the lower branches. Light or minor pruning can be done any time of year to correct imbalances or limb breakages. **However, major or heavy pruning should only be done in the early part of the year from January through April. Fall or early winter pruning can open up the canopy so that it is more prone to frost damage. The closed canopy holds in the heat better.**

The major reason not to prune in fall and early winter is that a perennial, evergreen subtropical like avocado goes into a quiescent stage during the fall in preparation for winter cold. The tree does not go dormant like an apple or peach but goes into a metabolic state that can better handle cold. By pruning in the fall, the tree becomes actively metabolic and more prone to frost damage. The tree needs to slow down to better handle the cold.

Avocados flower and bear fruit at stem terminals, so if you give the tree and buzz cut (heading cuts), all the flower terminals will be cut off and there will be no flowering the following year. It also leads to an explosion of water sprouts that result from bud break up and down the branch because the terminal bud which controls the buds lower down have been removed. Naphthalene acetic acid (Tre-Hold) painted on the cut end can be used to restrict some of this wild bud break.

Whenever possible, thinning cuts should be made, where the branch is removed back to a subtending branch. This results in much less wild growth. Also, when there are buds that start growing into water sprouts, they can be nipped back to force lateral growth. These laterals will then slow down the growth of the sprout and the side terminal buds will also be able to grow and transition of flower buds later. Work in Carol Lovatt's lab at UCR has shown that terminal buds need a certain maturity to flower and the transition from a vegetative bud to a flowering bud occurs sometime in late summer/early fall. If pruning is done in July, there is not enough time for the new buds to mature by August and there will be no flowers from that branch the following spring. New vegetative buds formed on growth from spring will often have enough maturation time to make the transition to flower buds, resulting in flowering the next spring.

Any major pruning done in later spring and summer is also going to require some protection for the remaining scaffolds from sunburn. Get ready to paint the scaffold with dilute latex paint to protect the once protected bark from sunburn damage. This can pretty rapidly kill the underlying cambium within days if it heats up newly exposed wood.

Light pruning can be done at any time of the year, but removing terminals is removing potential fruiting wood. Therefore, if heavy pruning is needed, it is best to remove one branch at a time. To reduce the height of a tree, cut out the tallest branch one year, the next tallest branch the following year, and so on until the tree is down to the height required. The process may take three to four years. By reducing the height over several years, the tree is put under less stress, less disease is likely to occur and fruit production is not drastically reduced. Pruning the sides of the tree should be done in the same way. Prune off a side branch that most impinges on a neighboring tree one year, then the next worst offender in the second year, and over the years continue this process until there is light all around the tree.
If pruning creates major open areas in the tree to sunlight where there once was shade, the exposed branches should be painted with white latex paint diluted with water so that it can be sprayed on. It needs to be white enough that it can reflect sunlight and avoid heat damage that can cause sunburn. Sunburn can utterly destroy all the work that has been done.

If the trees are really too large, the only real alternative is to bring the overall tree size down. But not stumping, rather scaffolding where much of the structure is maintained. This is where the tree is brought down to as high a height as is convenient and safe. By cutting the tree to a height of 8 feet or so, there is not so much rank regrowth because a greater portion of the tree is retained. Also, many times there are leafy branches that remain that will flower and fruit and slow the wild regrowth. Water sprouts that form should be headed back to force lateral growth that encourages stems that will flower, which will also slow the wild regrowth.

And one last warning. Do not. Do not. Do not. Got it? Prune sick trees. If the roots are compromised, the regrowth is going to be hard on the roots. Get the trees perked up with one of the phosphite products so that they are ready to go through this process. You may have to wait a couple years to start the pruning process until the trees are in shape for the rigors.

In summary: Late winter to early spring is the sweet spot for pruning your avocado trees. This timing is key because it sidesteps the risk of cold damage and aligns with the tree's natural flowering cycle. Pruning too late can lead to sunburned branches and a reduced fruit set the following year.

Care of Frost Damaged Trees

Determining the amount of damage is often a difficult job and cannot be done accurately for some months following the freeze. It is usually better to let the tree recover by itself.

Sunburn prevention

Exposed limbs can be badly damaged by sunburning. Whenever defoliated tree s have not grown enough new leaves to protect the limbs before hot weather occurs, you should provide protection. Protection is best provided by spraying or painting all exposed limbs with either a cold-water white latex paint or a whitewash. The paint needs to be white enough to reflect the light, but thin enough to flow through a sprayer. With latex paint, a 2-part latex to 1 part water is usually adequate.

Irrigation

Do not irrigate frosted trees until the soil in the root zone approaches dryness. The loss of leaves reduces the use of water so the soil will remain wet longer than with unaffected trees. Careful, frequent examination of the soil is necessary to prevent excess moisture from normal irrigations. Avocado root rot occurs in soils with excessive moisture when the cinnamon fungus is present, and growers must guard against this disease following frost damage.

Pruning

Do no pruning until you know how much of the tree has been killed. New foliage will grow from the remaining live wood and the tree will recover better without pruning.

When new shoots are at least two or three feet long, you can remove the dead wood. This will usually be mid-summer, 6 to 8 months following the frost. At the same time, suckers should be thinned out to select the new limbs to replace those lost.

Care of young trees

Badly frozen young trees usually develop strong sucker growth which can be used to form a tree as good as a replanted tree. If these suckers are from above the bud union, you can develop a new top by thinning and training. On young trees frozen back to below the bud union, strong root suckers can be budded or grafted to the desired variety the following spring. If the sucker growth is weak, the tree should be removed.

Severely frozen mature trees

The handling of severely frozen mature trees where they have been killed back to the large scaffold limbs, to the trunk, or to the ground, presents many problems. Each tree should be considered separately. Often growers should topwork badly frozen trees to a more resistant or productive variety.

The National Clean Plant Network, with emphasis on the National Clean Plant Network — Citrus

Robert R Krueger, USDA-ARS-NCGRCD, Riverside, CA

The National Clean Plant Network — Citrus (NCPNC) is a component of the National Clean Plant Network (NCPN), which also encompasses berries, fruit and nut trees, grapes, hops, roses, and sweet potatoes. The NCPN is a collaborative program between USDA Agencies APHIS, ARS, and NIFA. APHIS, through its PPA 7721 program, is the lead Agency and administers the NCPN. It originated about 2006, when industry, State regulatory, and USDA representatives met and developed the NCPN concept. The NCPN itself was established as a temporary program in the 2008 Farm Bill, which led to APHIS, ARS, and NIFA establishing the program through a memorandum of understanding in 2009. NCPN was reauthorized and made permanent in the 2014 and 2019 Farm Bills.

The NCPN is a network of "clean plant centers" and allied programs, mostly located at Universities but also including State and Federal Agencies (Figure 1). NCPN has the overall mission of supporting and promoting the use of "clean" propagative material in the production of its associated crops. "Clean" in this sense means free of either all known pathogens of a particular crop (for example, citrus) or free of regulated pathogens (most other crops in the network). This contributes to the overall health and sustainability of the agricultural sector as well as contributing towards food security in the United States. Within this overall mission, the NCPN carries out activities in several areas. Diagnostics identify pathogens in propagative stock plants. Therapeutics are applied to "clean" or "sanitize" these plants. Clean stock is maintained in Foundation (G1) plantings and distributed to the industry partners for increase and use. The NCPN also engages in special initiatives.

These activities are supported by a cooperative agreements program administered by APHIS and supporting critical staffing needs; equipment and supplies; infrastructure improvements; diagnostics, therapeutics, and foundation plantings; and governance and special initiatives. These Federal funds supplement other funds that provide the majority of support for the centers: institutional support, commodity boards, user fees, and, in some cases, research grants (NCPN funds cannot be used to support research but only the basic functioning of the centers).

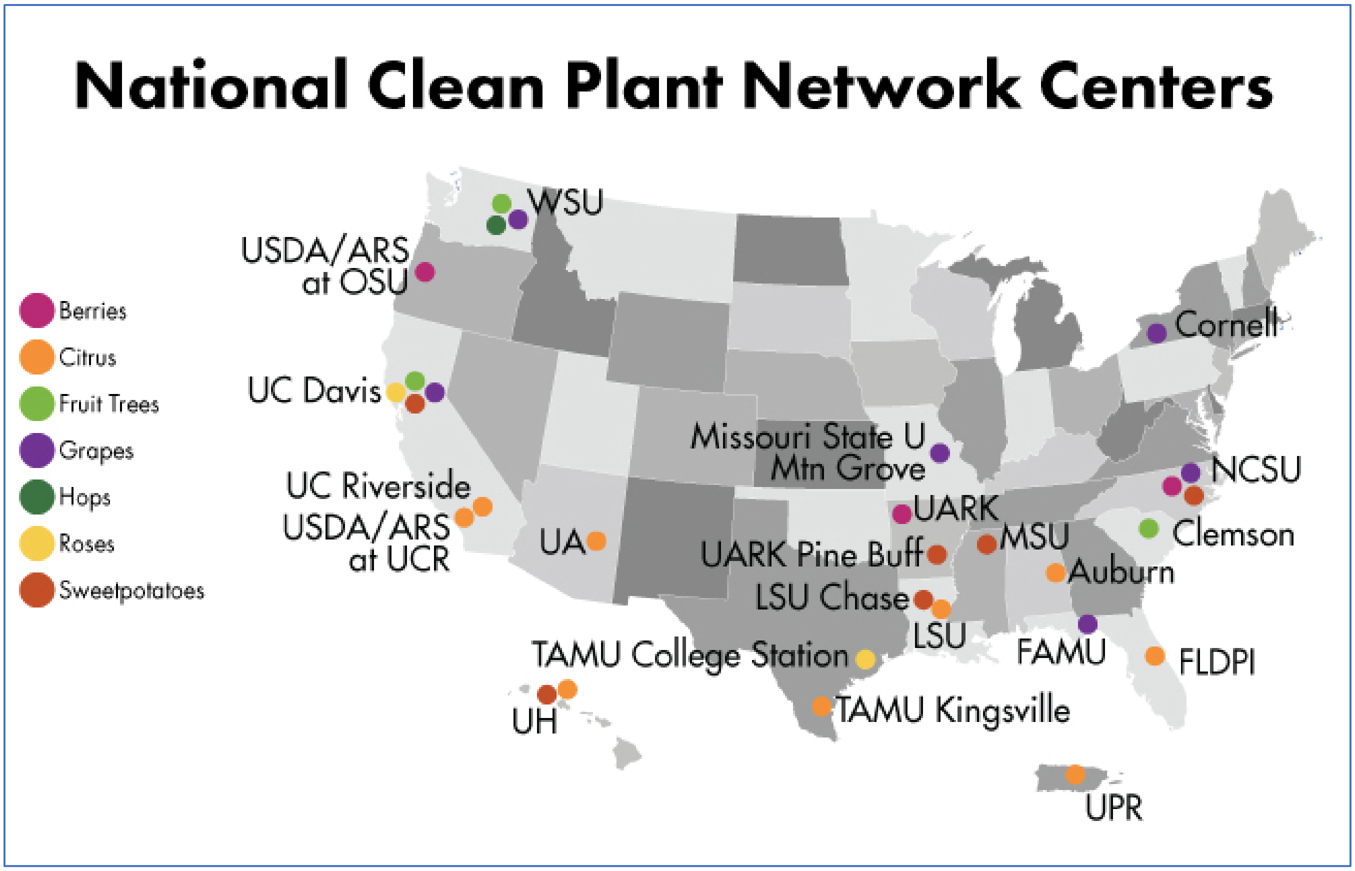

Figure 1. National Clean Plant Network Clean Plant Centers.

The NCPN promotes a distributed model of service from the geographically diverse clean plant centers. It brings together the centers, industry, researchers, State and Federal regulatory personnel together to discuss issues. The centers themselves vary in size and capacity. Larger centers serve regional and national needs, while smaller centers have a regional or State-level focus. Most centers also conduct research and extension programs and in some cases participate in a State-level certification or registration program. The center directors may provide expertise on regulatory issues and conduct research that supports the NCPN mission.

Commodity	Number of Centers	Number of Centers in CA	Accessions maintained	Units Distributed Annually
Citrus	10	2	2,700	575,000
Grapes	5	1	1,000	60,000
Fruit and Nut Trees	3	1	900	380,000
Berries	4	1	350	N/A
Sweet Potatoes	6	1	440	930,000
Roses	2	1	850	80,000
Hops	1	0	44	930

Table 1. Summary of National Clean Plant Network Clean Plant Centers.

Citrus has the largest number of clean plant centers, highest number of accessions maintained, and second highest number of propagative units distributed annually (Table 1). The use of clean propagative material in citrus has a longer history and the concept is better established in the citrus industry, particularly in California, than other commodities. This is due to the history of the citrus industry in California. The destructive nature of graft-transmissible pathogens was recognized early in the 20th century in California. This led to the development of the psorosis-free program in the 1930's, followed in the 1950's – 1960's with the more comprehensive Citrus Variety Improvement Program (later renamed the Citrus Clonal Protection Program, or CCPP). The use of clean propagative stock for citrus originating with the CCPP is embedded in the California Code of Regulations (Title 3. Division 4. Chapter 4. Subchapter 6. Section 3701). Thus, citrus has served as a sort of model for other commodities with regard to the use of clean propagative materials.

Within the NCPN, Foundation (G1) materials are held by the centers and distributed to nurseries (G2) for increase and/or propagation. In some cases, materials are distributed to individual growers. If a nursery is participating in a State-level certification or registration programs, the G2 materials must meet State standards regarding management, inspection, testing, and documentation. The current standard for citrus is that G1 materials are held in protective structures (greenhouses or screenhouses). For citrus, California has required G2 materials and tree production to be protected for about 10 years. Other states have somewhat different requirements, but the trend is for completely protected production. Other commodities may have different requirements. For crops under a State-level certification program, the materials must be free of target pathogens according to the standards for the program. For crops with no certification programs (for example, roses) or with a limited program (for example, sweet potatoes), testing may focus on a target list of significant pathogens. In the cases of citrus, all graft-transmissible pathogens are targeted. This is again due to the history of clean plant use in citrus.

Although the processes and technologies used are similar (Figure 2), sanitation of domestically- and internationally-sourced germplasm is different regulatorily. The State-level programs mentioned in the previous paragraph are regulated by the States, whereas the introduction and sanitation of germplasm derived from international sources is regulated by the Federal Government. Introduction of citrus, and most other clonal crops, from foreign sources is done under an APHIS Plant Controlled Import Permit (PCIP), which spells out the testing, therapeutic, and other requirements. Currently, seven NCPN centers have programs and permits to introduce internationally-sourced germplasm. Of these seven, three are citrus clean plant centers: the University of California Riverside Citrus Clonal Protection Program, the USDA-ARS National Clonal Germplasm Repository for Citrus & Date (NCGRCD; also in Riverside), and the Florida Division of Plant Industry Citrus Germplasm Introduction Program. In passing, of the seven NCPN plant importation programs, three are in California: the CCPP, NCGRCD, and Foundation Plant Services at University of California Davis.

Of the 10 citrus clean plant centers, 3 are considered the "major" centers: CCPP, NCGRCD, and Florida DPI. These centers have comprehensive programs of sanitizing, maintaining, and distributing large quantities of a wide range of varieties. Citrus clean plant centers in the smaller citrus-producing states mostly maintain Foundation/G1 materials of a limited number of varieties of local or State-level importance, sometimes with limited pathogen testing. The major centers provide sanitized germplasm to establish these G1 collections, and sometimes send propagative materials to the minor citrus-producing states.

Special initiatives of the NCPN include: education and outreach; advanced diagnostics; quality initiative; and economics. In several of these areas, citrus is again somewhat in the forefront of other commodities. The concept of the value of clean citrus propagative material has been well established for decades, so outreach in this area for citrus is not a high priority as compared with other commodities. On the other hand, the illegal introduction of citrus germplasm, in some case accompanied by exotic pests, illustrates that our work is not complete in this area, even if the target audience is more the general public than the citrus nursery and production industries. Similarly, the economic value of using clean propagative material is widely accepted in the citrus industry.

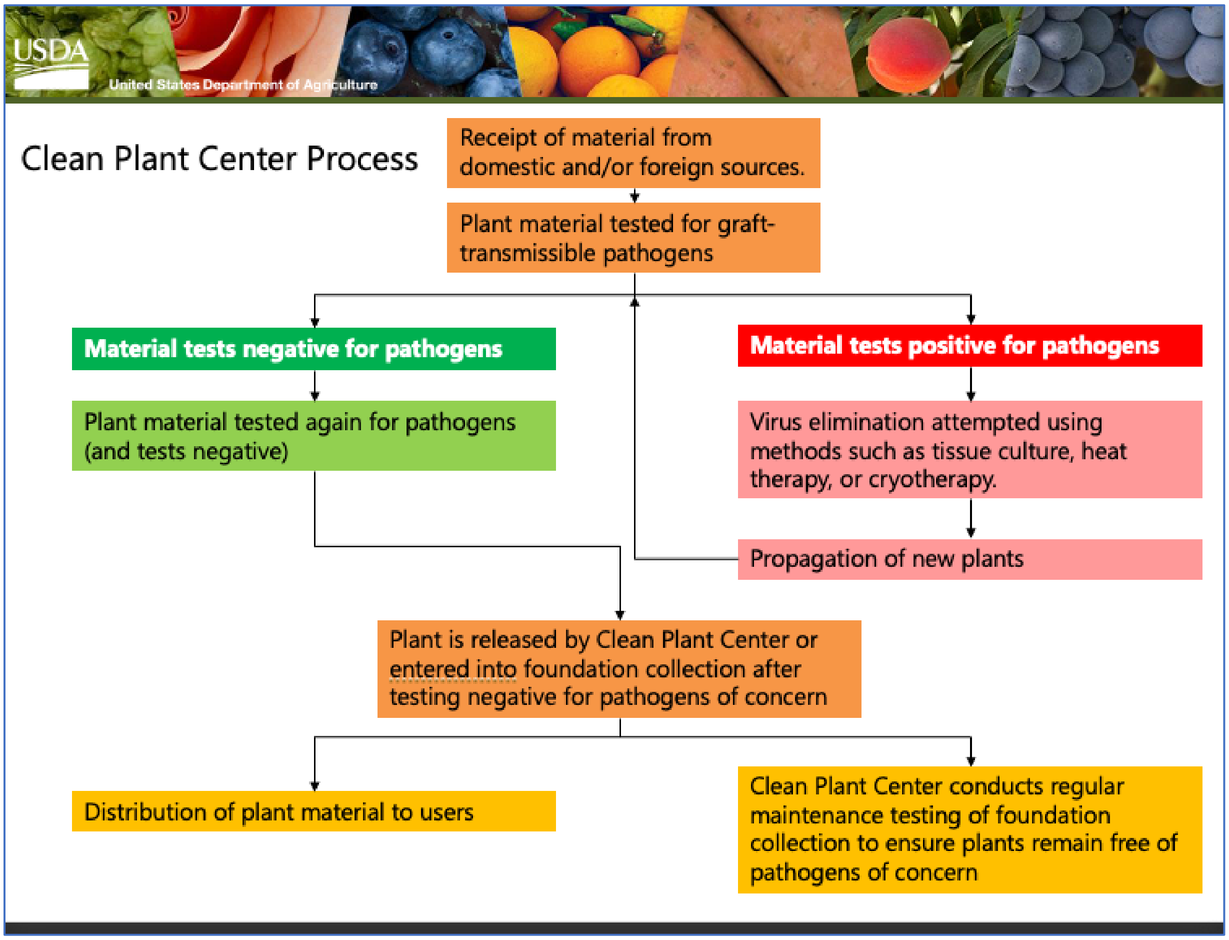

Figure 2. Generalized schema of clean plant center processes.

Overall, the NCPN provides arrange of benefits to the agricultural industry. The increased support of the clean plant centers makes up for potential or actual shortfalls from other funding sources and increases the production of clean plants for use by the industry, as well as improving the technical capabilities of the centers. This gives the nursery industry increased access to clean propagative materials, which improves the quality and value of the plants produced. Growers in turn reap economic benefits from higher quality and yields due to decreased disease pressure. The industry overall has increased access to new varieties, whether developed domestically or internationally, with greatly reduced risk from disease spread. The NCPN also has as its core the network concept, which facilitates discussion and collaboration between scientists, stakeholders, and regulatory personnel. Overall, this distributed network provides a positive contribution to agricultural productivity and food security.

Development of integrated pest management for huanglongbing (HLB) in Florida

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Huanglongbing disease (HLB), putatively caused by *Candidatus* Liberibacter asiaticus (CLas) and primarily transmitted by the insect vector Asian citrus psyllid (ACP; *Diaphorina citri*), has brought the Florida citrus industry to the brink of collapse. And HLB continues to spread and threaten other production areas worldwide. Thus far, despite sustained and considerable funding and research, no resistant citrus cultivars or successful prophylactic or post infection treatments have been developed. This century-old disease has been the most challenging citrus epidemic to study or investigate effective management strategies.

The large University of Florida Institute of Food and Agricultural (UFL IFAS) research team at the Southwest Florida Research and Education Center in Immokalee, FL, has been investigating HLB for more than a decade. As a result of above noted inability to develop cultivars resistant. or effective treatments for HLB they have elected to design an integrated pest management (IPM) strategy for controlling HLB.

This strategy utilizes several “tools” that have been demonstrated as effective in controlling HLB/ACP, including the use of individual protective covers (IPCs), trunk injection of oxytetracycline (OTC), and application of brassinosteroids (Brs) and systemic acquired resistance inducers (SARs) in the orchards. Additional tools, including HLB-tolerant interstocks and an automated trunk injection system (ATIS), are currently being evaluated. In several field studies using these strategies, they demonstrated the efficacy of 1) IPCs in preventing CLas infection, 2) OTC in the reduction of CLas titers and fruit-drop, 3) Brs and SARs in increasing tree productivity and protecting new shoots from ACP-mediated CLas reinfections and from citrus canker, and finally 4) ATIS in improving injections by accelerating the speed of delivery (up to 250 ml in about 1 minute). Their collective results indicate that these IPM tools, used in sequence or simultaneously, can result in limited control of HLB disease in commercial citrus orchards and potentially provide a path for sustainable citrus production under endemic HLB. Florida growers are now adopting some of these tools, hoping to reverse the decline in production since HLB was discovered in Florida.

An effective IPM program for HLB incorporates these elements:

- **IPM ACP-HLB Program Elements:**
    - Reduction of the Asian citrus psyllid (ACP) populations; to decrease the HLB spread. Specific program elements listed in black below

- Visual identification and prompt removal of infected trees; to decrease the HLB disease reservoir. Specific program elements listed in red below
- Production of propagation material in insect-proof facilities; to replace HLB infected trees with healthy trees
- Psyllid vector control: one in **bold** pictured in **Fig. 1.**
    - Chemical and biological control; to decrease ACP population
    - Reflective mulch, Kaolin spray; to deter ACP feeding
    - **Protective screens (CUPS and IPC); to prevent ACP feeding: Fig.1**
    - Removal of preferred alternative hosts; to decease ACP population by decreasing alternative habitats
- HLB disease control**:**
    - Remove and destroy infected trees; to destroy the disease reservoir.
    - Quarantine program; to prevent introducing infected trees
    - Chemotherapy and nutritional treatment; to slow disease progression in infected trees and prolong orchard productivity
    - Thermotherapy (Heat/steam treatment); to decrease pathogen in the tree
    - Bactericides, antimicrobials, and 'snake oils.'; to reduce the pathogen in the tree
    - CRISPR, RNAi, and transgenic approaches?; lone term solution of resistance. Not achieved yet.

Pictured below one element of the current Florida IPM control strategy:

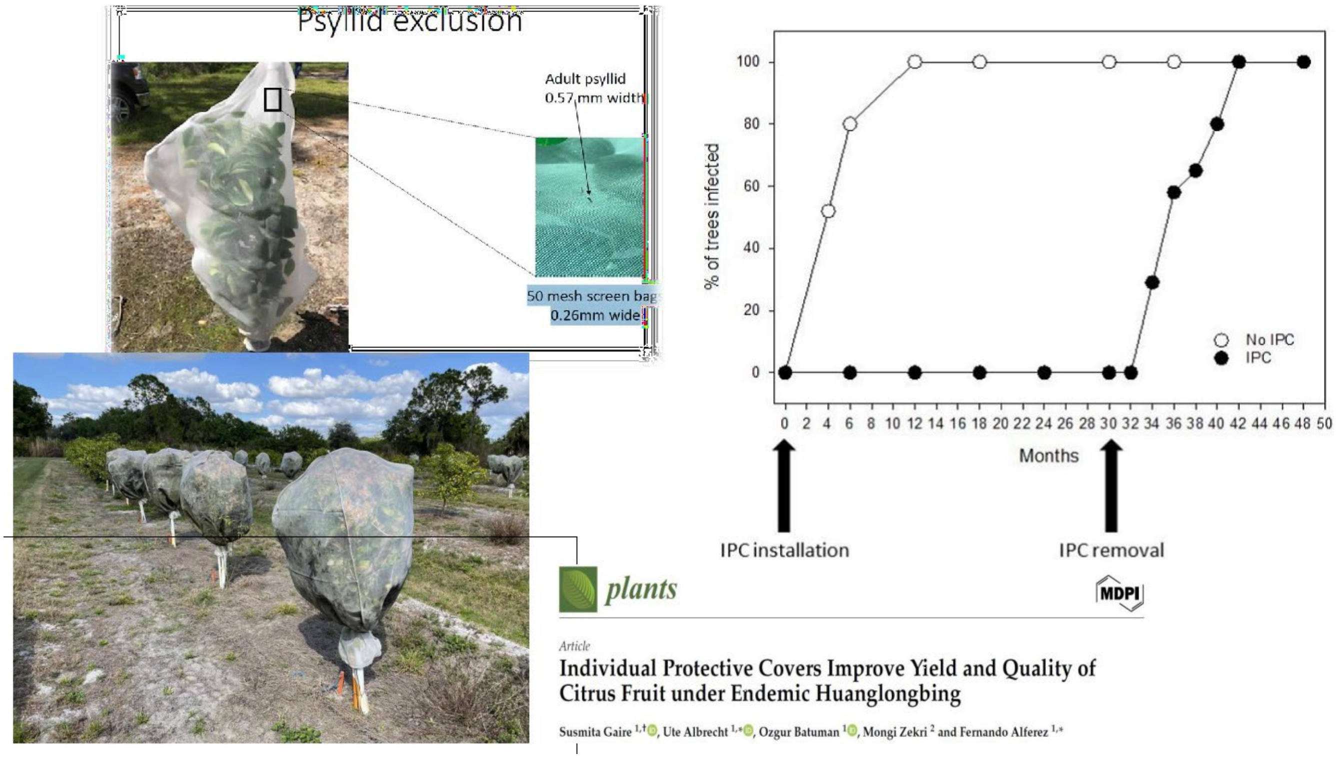

Fig.1 Protective screens (CUPS and IPC); to prevent ACP feeding:

Conclusions thus far are that there is no single “silver bullet” for HLB in Florida; growing citrus in Florida remain expensive and at risk.. Most chemical strategies and therapeutics have failed to prevent, eradicate or even manage HLB. The use of individual protective covers, (ICPs) to prevent ACP feeding, combined with Oxytetracycline delivered through a yet to be fully developed rapid automated trunk injection delivery system remains the greatest hope, and most viable strategy at this time

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<u>SAVE the DATE</u>: Citrus Day
University of California
February 5, 2025

Topics in Subtropics

Newsletter by Tree Crops Farm Advisors

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