Finding Solutions for Florida’s Citrus Growers:

2018-2019 State Legislature Funding for UF/IFAS Citrus Initiative
Over 70 percent of Florida growers think that continued scientific pursuit of a major breakthrough in defeating citrus greening is a viable opportunity.

2019-2020 Florida Citrus Industry Pulse Survey

I believe there is an opportunity to redevelop the citrus industry based on current research.

Survey respondent 2019-2020 Florida Citrus Industry Pulse Survey

Cover photo by: Tonya R. Weeks
Dear Friends,

Citrus is intrinsically tied to the Floridian experience. We grow more of it than anywhere in the world. We are the center of orange juice production for the United States. Citrus groves have long defined our landscapes.

Yet, since the early 2000s, an invasive insect, the Asian Citrus Psyllid (ACP), has transmitted a deadly citrus disease to virtually every grove in Florida. The result has been devastating. Orange production in Florida dropped from 245,000 boxes in 2003/2004 to an all time low of 45,000 in 2017.

But Florida growers, the state legislature, and scientists responded rapidly and aggressively. Funding to find solutions was provided and research agendas were redirected to learn more about the insect, the pathogen, how it effects the citrus tree and, most importantly, find growing practices that support Florida’s citrus growers.

At the University of Florida Institute of Food and Agricultural Sciences, researchers have discovered ways to control the insect, provided the best nutrition and irrigation methods to support trees, developed varieties that are more tolerant to the disease, and created innovative techniques to enable citrus groves to survive and thrive in this new environment.

This publication provides brief summaries of specific research projects that were made possible by state legislative funding for the UF/IFAS Citrus Initiative during the 2018-19 funding cycle. It documents how we are making progress and providing Florida growers with reasonable, pragmatic solutions to successfully grow citrus in this new age of citrus greening.

These funds were allocated directly to UF/IFAS to support projects that provide immediate solutions that growers could implement now or provide valuable information that will lead to transformative discoveries. These funds are distinct from funds allocated to the Citrus Research Development Foundation (CRDF).

Financial support for research is working. Continued financial support is needed so we may build on this knowledge portfolio and secure the future of Florida citrus. Together we are making significant progress.

Sincerely,

Jack M. Payne
Sr. Vice President
Agriculture and Natural Resources

Michael E. Rogers
Director and Professor
UF/IFAS Citrus Research and Education Center
Generating HLB-Resistant Citrus Using Gene Editing

**Researcher:** Nian Wang, Microbiology and Cell Science

**IMPACT:** Significant progress has been made in the identification of genes that make the citrus plant susceptible to HLB as well as genes that make citrus resistant to HLB, moving closer to generating a citrus greening-resistant plant. Progress has also been made to optimizing the gene editing CRISPR technology and generation of HLB-resistant citrus using biotechnology. Multiple plants have been generated and are being tested for HLB resistance. There is also greater understanding of the biology of the bacteria that causes HLB. All these results will help the industry with short and long-term solutions to control HLB.

The goal of multiple research initiatives led by Nian Wang of the UF/IFAS Citrus Research and Education Center is to generate HLB-resistant citrus via biotechnological approaches such as gene-editing with the CRISPR technology. In the process, researchers have confirmed the HLB-susceptibility genes in the citrus genome. Identifying the HLB-susceptibility gene will lead to understanding how to “turn off” that gene through biotechnological approaches. This in turn leads to generating a non-transgenic, HLB-resistant citrus plant. In a companion study done by Wang, canker-resistant citrus plants have been generated by turning off a susceptibility gene showing the potential of this approach.

Multiple genome-modified plants have been generated and are being tested for HLB resistance. In the process, the efficacy of genome editing has been increased. Some genome-modified citrus plants generated with additional biotechnological approaches have showed lower bacterium levels or no infection compared to control plants.

Researchers have also made significant progress in understanding the biology of the bacterium. This information is helpful in designing new control strategies. These strategies include knowing the most efficient methods needed to control the bacterium and being able to detect the bacterium before symptom appearance in trees. All these findings will help the industry with some short-term solutions.

Why Does Fruit Drop Prematurely?

**Researcher:** Tripti Vashisth, Horticultural Sciences

**IMPACT:** Researchers found that fruit from severely HLB-symptomatic trees drop significantly more than mildly symptomatic trees. The fruit that drop are smaller sized than those that do not drop and are not deficient in carbohydrates. Thus, other factors that can influence the fruit size such as water uptake and hormonal balance should be studied in future research projects.

Commercial citrus trees routinely lose some of their developing fruit before harvest. This phenomenon, known as fruit drop, happens at three growth stages: during spring flowering, a month or two after flowering, and during the last few weeks before harvest. The matured fruit simply drop to the ground and cannot be marketed, so they are considered waste. Observations indicate that Florida groves affected by citrus greening disease, also known as Huanglongbing or HLB, often drop an unusually high percentage of their fruit just before harvest — up to 40% in some cases.

Because scientists are uncertain how HLB may promote premature fruit drop, UF/IFAS Citrus Research and Education Center horticulturalist Tripti Vashisth led a study to investigate the disease’s effect on fruit drop. First, the trees were classified into three groups, based upon the severity of visible disease symptoms. Further observations showed the severely affected trees had lower yields, produced smaller fruit, and dropped a greater percentage of developing fruit compared with less-affected trees. Also, the fruit remaining on severely affected trees were more likely to be loosely attached.

Though the researchers did not pinpoint the cause of premature fruit drop, previous experiments have indicated it cannot be remedied with pruning, thinning or application of plant hormones. This was the first citrus study to report that there is a relationship between fruit size and fruit drop.

Citrus Youth Day successfully introduced the citrus industry to new audiences.
**Nutrient Management of HLB Affected Round Orange and Grapefruit**

**Researchers:** Kelly T. Morgan, Soil and Water Sciences, Davie Kadyampakeni, Soil and Water Sciences, Rhuanito Ferrarezi, Horticultural Sciences

**IMPACT:** Increased rates of Ca and Mg applied three times per year increased tree canopy growth. Below-ground root growth was also increased which is important in improving nutrient uptake to help rehabilitate HLB-diseased trees. The study also found that by enhancing rates of Mn and Zn overall, the health and growth of HLB-diseased trees could be improved even further. In addition to improving fertilization practices, adjusting tree planting density can help improve overall fruit yields.

The bacterium responsible for citrus greening disease does much of its initial damage below ground, reducing the host tree’s overall fibrous root density by 30% to 70%. This root loss makes it harder for infected trees to acquire water and nutrients from the soil. Because virtually all Florida commercial citrus groves are now affected by citrus greening disease, also known as Huanglongbing or HLB, the state’s citrus growers often find that they need to apply nutrients in smaller amounts, at more frequent intervals, than they did in the days before HLB. Research has also found that applications of Calcium (Ca), Magnesium (Mg), Manganese (Mn) and Zinc (ZN) must be applied to improve tree growth, root development, and yield.

Many growers now spray their groves with liquid fertilizer mixtures containing macro- and micronutrients to supplement the use of dry granular fertilizer applied to the soil. To help orange and grapefruit producers better understand the pros and cons of fertilizer sprays, soil and water scientist Kelly Morgan of the UF/IFAS Southwest Florida Research and Education Center lead a research project investigating how fertilization rate and tree spacing influenced fruit size and yield. The project involved HLB-positive orange trees planted at Southwest Florida Research and Education Center in Immokalee and Citrus Research and Education Center in Lake Alfred and grapefruit trees planted at Indian River Research and Education Center at St. Lucie County. Experiments were conducted using ground applications of macronutrients (Ca and Mg) and foliar and ground applications of micronutrients (Mn and Zn) on separate groups of trees. Experiments at Indian River Research and Education Center conducted the same experiments on grapefruit trees planted in single rows and staggered rows.

Results after one year of application indicated that the soil and foliar fertilizer application rates had no significant effect. However, applications of Ca+Mg and micronutrients for three years increased canopy and root growth. Researchers have secured funding to continue the study for two more years to determine whether treatment effects change over time. Experiments on high-density grapefruit indicated that single row spacing provided the greater yield than staggered rows.

**Finding Natural Sweetness Enhancers in Citrus That May Lead to Citrus Beverages with Lower Sugar Content**

**Researcher:** Yu Wang, Food Science and Human Nutrition

**IMPACT:** Newly developed HLB-tolerant varieties developed by UF/IFAS could provide consumers with better tasting orange juice with lower sugar content.

U.S. demand for orange juice has dropped in recent years. Many citrus growers believe it is because consumers want to limit their sugar intake, especially from fruit juices. But a new UF/IFAS project indicates science may provide a solution. Food chemist Yu Wang, an assistant professor with UF/IFAS Citrus Research and Education Center, has determined that some citrus fruits contain compounds that are natural sweetness enhancers — not sugars, but chemicals that intensify the sensation of sweetness when consumed with foods that contain sugar.

Wang made the discovery while evaluating new mandarin varieties developed by UF/IFAS citrus breeders. She selected one UF/IFAS mandarin variety and a commercial cultivar with a similar ratio of sugars to acids, and asked taste panel participants to rank the perceived sweetness of both. Surprisingly, panelists indicated that the UF/IFAS mandarin tasted much sweeter than the commercial variety — despite their similar sugar-to-acid ratios. Wang plans additional studies to assess whether these compounds enhance the sensation of sweetness or if they might themselves be sweeteners of a previously unknown type that could prove valuable to Florida orange juice processors who are struggling with declining juice sales.

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2018-2019 State Legislature Funding for UF/IFAS Citrus Initiative | 5
**Effects of Homobrassinolide on HLB-Affected Citrus Trees**

**Researchers:** Fernando Alferez, Horticultural Sciences; Tripti Vashisth, Horticultural Sciences; and Christopher Vincent, Horticultural Sciences

**IMPACT:** Research has shown that a currently available product called homobrassinolide (HBR) can improve tree health, increase fruit yield, and improve internal fruit quality of HLB-diseased citrus trees. Growers may use this product now.

Brassinosteroids are a class of plant hormones associated with development and stress tolerance. In early 2016, a Cuban scientific study asserted a compound from this group could reduce pathogen concentrations in citrus trees affected by citrus greening disease, also known as Huanglongbing or HLB. In response, a UF/IFAS research team led by horticulturalist Fernando Alferez of the Southwest Florida Research and Education Center set out to assess the potential of a related compound, homobrassinolide.

At two UF/IFAS research facilities in central and southwest Florida, Alferez and his colleagues designed an experiment involving outdoor-grown Valencia sweet orange trees that were 6-8 years old and HLB-positive. The trees were divided into three groups and every other week for six months, each group was treated with a solution that contained a low concentration of homobrassinolide, a high concentration, or pure water with no homobrassinolide.

Approximately one year into the study, researchers found no differences in the concentrations of HLB pathogen between the treatment groups. However, homobrassinolide apparently promoted earlier flowering, faster fruit development and earlier, larger yields, all of which are potentially beneficial to growers. Results from the second year indicate trees receiving the lower concentration of homobrassinolide had 21% greater yield than the untreated trees, and better internal fruit quality. Trees receiving the higher concentration had 10% greater yield. Alferez has launched an additional study to determine whether homobrassinolide may help young citrus trees shrug off the HLB pathogen and remain healthy. Work continues to develop precise recommendations that growers can use to sustain productivity of HLB-diseased trees.

**Bactericide Applications for HLB Control**

**Researcher:** Nian Wang, Microbiology and Cell Science

**IMPACT:** Findings suggest that bactericide applications as legally allowed at present may have no significant benefit to greening-affected trees.

In 2017, the U.S. Environmental Protection Agency granted an emergency exemption to Florida citrus growers, allowing them to test bactericide applications. The exemption permitted growers to spray their trees with solutions containing the bactericides oxytetracycline and streptomycin to fight citrus greening.

Recent studies led by UF/IFAS Citrus Research and Education Center microbiologist Nian Wang indicated these compounds had no significant benefit to trees when applied in spray form because very little bactericide made its way into the leaf where the pathogen resides.

However, a companion study suggests that bactericides provide excellent control of greening disease when injected into the trunks of affected trees.

Wang and his associates conducted field trials using three bactericides and eight environmentally friendly compounds believed to activate or fortify natural defense systems in plants. The results showed that any of the bactericides — oxytetracycline, streptomycin, and penicillin — when injected into the tree could provide excellent control of HLB, by reducing bacterial concentrations and halting disease progress. Four of the environmentally friendly compounds provided significant disease control, though generally they did not perform as impressively as the bactericides.

At present, federal regulations do not allow U.S. citrus growers to apply bactericides to citrus trees via trunk injection, but Wang plans to continue researching this application method to explore its potential benefits and drawbacks that can be used to help facilitate the registration of these bactericides using trunk applications.
Improving Citrus Plant Health from the Ground Up

**Researcher:** Nian Wang, Microbiology and Cell Science

**IMPACT:** New understanding of the working relationships of microorganisms in the soil that surrounds the roots of the citrus plant presents opportunities to control citrus greening disease.

Working with soil samples collected from six continents, Nian Wang of the UF/IFAS Citrus Research and Education Center identified both beneficial and harmful microorganisms that contribute to better nutrition acquisition and plant growth. Learning more about the soil system may lead to options that could modulate the citrus soil microbiome and improve plant production and health. A synthetic microbiome has been identified that has potential to benefit citrus against plant pathogens and promote plant growth.

Additional research looked at manipulating the citrus plant’s rhizobacteria to trigger an immunity to protect against citrus canker. Results were positive under greenhouse conditions.

Finding Another Key to Developing a Greening—Resistant Citrus Tree

**Researcher:** Manjul Dutt, Horticultural Sciences

**IMPACT:** Researchers are one step closer to developing a greening-resistant citrus variety and one that will result in long-term resistance to the disease. Progress is being made in understanding how genetically engineered citrus reacts to HLB and identifying genetically engineered rootstocks that can potentially protect trees in the future.

Citrus greening disease, also known as Huanglongbing or HLB, is the result of an infection by the bacterium *Candidatus Liberibacter asiaticus*. Though the concept of HLB-resistant citrus is simple, the process of developing such a variety is complex, requiring scientists to understand genetic mechanisms that increase resistance or decrease vulnerability to infection. Both goals are being pursued by horticulturalist Manjul Dutt, a research assistant scientist with UF/IFAS Citrus Research and Education Center.

In one recent study, Dutt grafted HLB-infected sweet orange scions to rootstocks that had been genetically engineered to produce a compound that confers resistance to pathogens. In this project, results indicated that the compound traveled from rootstock to scion and significantly reduced the concentrations of HLB bacterium in the scion. A companion study showed it was possible to “turn off” a gene that naturally occurs in sweet orange and interferes with its ability to produce a greening-resistant compound. If the tree could then produce more of the resistant compound, it could use its own natural defenses more effectively to fight greening. This discovery opens the door for Dutt and collaborators to employ CRISPR gene-editing technology and develop gene-edited citrus varieties that can effectively combat the HLB pathogen.

There have been 1,115,205 website visits for canker, HLB, citrus black spot and citrus economics information.
Do Propagation Methods Impact Field Performance of Citrus Trees?

**Researchers:** Ute Albrecht, Horticultural Sciences and Rhuanito Ferrarezi, Horticultural Sciences

**IMPACT:** Florida growers are engaged in replanting thousands of acres of citrus groves. A commercial citrus tree consists of two parts, an above-ground part that bears the fruit (the scion) and a below-ground part that provides the root system (the rootstock). Choosing the right rootstock/scion combination is crucial to success. Traditionally, rootstocks are grown from seed. This research shows that it is more important to select the right rootstock for an environment than it is to worry about how the rootstocks were propagated in the nursery.

The endemic presence of HLB has forced growers to rethink many of their management practices. A UF/IFAS citrus research team is investigating a question growers are asking when deciding on whether the propagation method used to generate the rootstock makes any difference. Rootstocks may be propagated three ways — from seed, cuttings or tissue culture. UF/IFAS plant physiologist Ute Albrecht of Southwest Florida Research and Education Center and colleagues conducted a study to determine whether propagation methods used for rootstocks has an influence on growth of the scion.

The study was conducted in three counties, using Valencia sweet orange scions grafted to eight rootstock cultivars. Measurements of the trees’ height, trunk diameter, and canopy size were collected, and the health of each tree was assessed. Rootstock variety was a much more significant factor in tree growth than the propagation method involved.

As growers are replanting their groves and trees are in short supply, growers should have more confidence in buying rootstocks regardless of whether they are grown from seed or generated by other methods, namely cuttings or tissue culture. This allows nurseries to produce trees in a shorter amount of time and growers to get the desired trees and replant at a faster rate. This is important for the survival of the citrus industry which is suffering from the devastating effects of Huanglongbing (HLB, a.k.a. citrus greening).

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Finding Natural Biocontrols for the Asian Citrus Psyllid

**Researchers:** Ozgur Batuman, Plant Pathology; Amit Levy, Plant Pathology; Kellee Britt, Plant Pathology; and Mahnaz Rashidi, Plant Pathology

**IMPACT:** Scientists have discovered new naturally occurring viruses that may be utilized to control psyllids without the use of potentially environmentally harmful insecticides in the future. Research suggests that the process would adversely affect psyllid biology and kill the insect or prevent the greening pathogen transmission to citrus trees.

The bacterium responsible for citrus greening disease is transmitted by a tiny flying insect, the Asian Citrus Psyllid (Diaphorina citri, ACP), when it feeds on a citrus tree’s new shoots and leaves. This invasive pest is now established throughout Florida’s commercial citrus groves, so growers use insecticide sprays that are potentially harmful for the environment as one of their primary tactics for fighting citrus greening. By reducing psyllid populations in their groves, growers hope to increase the quality of fruit and the productive lives of their trees by minimizing the number of times they are infected with the greening pathogen.

Psyllid management might be improved if scientists could harness the insect’s natural enemies as control agents, thus reducing the need for insecticide use. With this idea in mind, a UF/IFAS team led by plant pathologist Ozgur Batuman of Southwest Florida Research and Education Center has been investigating viruses that dwell within the Asian Citrus Psyllid’s digestive system, to determine whether any of them can weaken or kill the insect.

For two years, researchers made monthly collections of psyllids from commercial citrus groves in 22 central and south Florida citrus production counties, to isolate and identify microorganisms (i.e., viruses) within their bodies. They made major steps forward in identifying ACP-associated viruses as well as understanding the presence of those viruses in the Florida ACP populations for the first time since the introduction of the ACP into Florida in 1998.

Future experiments will investigate how these viruses can be manipulated so that they may alter the psyllid’s biology, as well as how they affect survival and transmission of the pathogen that causes citrus greening disease, also known as Huanglongbing or HLB.
Relationship Between HLB and Virulence Factors and/or Plant Signaling Molecules

**Researcher:** Nabil Killiny, Plant Pathology

**IMPACT:** A key chemical responsible for HLB-disease symptoms in citrus trees was identified. This finding may lead to developing strategies to better manage diseased trees and enhance overall tree health. This information will be used in future studies designed to reverse disease symptoms and improve citrus growth and production.

One obvious symptom of citrus greening disease is leaf chlorosis — yellow blotches appearing on otherwise dark green citrus leaves. Although chlorosis can indicate other health issues, in trees affected by greening, it’s thought to be triggered by the underlying bacterial infection causing the disease.

To explore this possibility, UF/IFAS plant pathologist Nabil Killiny of the UF/IFAS Citrus Research and Education Center conducted a comparison study showing the chemical components of sap taken from healthy Valencia sweet orange trees, and sap from counterpart trees affected by citrus greening, also known as Huanglongbing or HLB. Killiny and his colleagues identified 39 compounds common to healthy and HLB-affected trees, and they noted increased amounts of several acids in sap from the HLB-affected trees. One of these, an organic acid, had increased in both the xylem tissue — which circulates water throughout the tree tissues — and the phloem tissue — which distributes nutrients in a similar manner. This finding led Killiny to hypothesize that the organic acid may function as a plant signaling molecule in HLB-affected trees, capable of traveling through the xylem into bacteria-free tissue and producing leaf chlorosis there. A follow-up study confirmed the hypothesis, showing that applications of this acid caused healthy Valencia trees to develop leaf chlorosis. This finding suggests that increased organic acid production in HLB-affected trees has a negative effect on the biochemical systems responsible for producing leaf pigment. Also, now that organic acid has been shown to induce some HLB-like disease symptoms in healthy trees, researchers may use it to investigate factors that contribute to the development of HLB, such as nutritional deficiencies.

Can Shade Help Trees Fight Citrus Greening?

**Researchers:** Christopher Vincent, Horticultural Sciences; Yu Wang, Food Science and Human Nutrition; and Nabil Killiny, Plant Pathology

**IMPACT:** Providing shade for HLB-affected citrus trees may result in reduction of HLB symptoms, improved water uptake, improved photochemical performance and possible reduced attraction of the Asian Citrus Psyllid, extending the trees’ productive lives.

Like all photosynthetic plants, citrus trees need light to produce food. But in Florida, groves located in full sun sometimes receive more light energy than they can utilize. When this happens, photosynthesis slows down and the plants invest their energy in protecting their leaves from sun damage. Consequently, the trees have less food available for fruit production.

In groves affected by citrus greening disease, this situation is especially serious. The disease interferes with transport of carbohydrates from citrus leaves to other parts of the tree, making it less likely the tree will benefit from the carbohydrates it does manage to produce. Reports suggest that citrus trees under shaded conditions are more tolerant of greening disease, so UF/IFAS Citrus Research and Education Center tree physiologist Christopher Vincent investigated whether there were differences in the health of HLB-positive citrus trees growing in full sun, versus partial shade.

They located naturally occurring stands of grapefruit trees that are periodically shaded, and collected data indicating that shade exposure promotes optimal photosynthesis, and that it greatly reduced citrus greening infections by reducing the number of disease-transmitting insects that arrived. In a second experiment, the team assessed the effects of shade on sweet orange trees that were previously established in full sun and were all HLB-affected. The team constructed shelters for treatments that provided 30%, 50%, or 70% shade, plus a control group receiving full sun. Results after one year indicate that trees receiving 30% and 50% shade were holding more water in their tissues at midday — an important indicator of tree health — compared with trees receiving full sun or 70% shade. In a two-year follow-up study, team members hope to determine the amount of shade needed to reduce symptoms in greening-affected trees, enabling them to explore shading of trees as a strategy for mitigating HLB symptoms. In the future, this might be accomplished by spraying clay materials directly onto trees to provide the amount of shade needed to increase productivity of HLB-affected trees.
Finding the Cause of Bark Scaling in Florida Citrus Groves

**Researcher:** Amit Levy, Plant Pathology

**IMPACT:** Growers are placing a lot of hope and money into planting newly developed citrus varieties that are more tolerant of HLB. However, some growers are experiencing new disease issues like bark scaling which can reduce the productivity of these new varieties.

This research has been important in ruling out certain suspected pathogens and is narrowing in on finding the true pathogens involved in this new problem. This work is important for ensuring success of groves being planted now that will sustain the citrus industry over the next 20 years.

When a commercial citrus research grove in Polk County experienced issues with bark scaling during field trials of newly developed citrus varieties, UF/IFAS plant pathologist Amit Levy investigated. Together with colleagues, he developed a process to screen for diseases found in Florida citrus that are caused by viroids or viruses. Levy tested numerous samples from trees in the affected grove, including asymptomatic trees and specimens expressing strong symptoms. He determined that none of the six pathogens under investigation were responsible for the mysterious outbreaks of bark scaling, suggesting a previously unknown causal agent might be present. A second round of sampling and analysis ended with the same result. This set the baseline, ruling out viroids and other viruses as the cause of this problem. Having established the process for testing for some viruses, other grower problems can now be tested quickly.

Cause of Dieback in Bingo Mandarin

**Researchers:** Megan Dewdney, Plant Pathology; Christopher Vincent, Horticultural Sciences; Liliana Cano, Plant Pathology

**IMPACT:** The ‘Bingo’ mandarin is a promising citrus variety that many growers have planted, so understanding why the branches of many trees have died in the field is an urgent need. One or more species of *Colletotrichum* fungi were associated with twig dieback in ‘Bingo’ mandarin, but demonstrating infection requires more definitive research.

In recent years, California growers have boosted demand for fresh citrus by promoting their seedless, easy-peel mandarins as healthy snacks. Florida citrus producers were interested and UF/IFAS citrus breeders responded with a series of seedless mandarin hybrids, beginning with an early-season variety known as ‘Bingo’, released in February 2015. Bingo produces a small fruit with good flavor, that ripens in October, providing Florida growers with a marketing window in which they do not compete directly with California mandarins, which ripen later in the season. To date, more than 150,000 ‘Bingo’ trees have been planted in Florida, but growers have reported an unexpected problem — excessive twig dieback, a condition that reduces the tree’s leaf canopy dramatically, diminishing both photosynthesis and fruit production.

In hopes of pinpointing the cause and offering a solution, UF/IFAS plant pathologist Megan Dewdney and colleagues conducted studies to determine whether the dieback phenomenon involved fungi representing the genus *Colletotrichum*. This genus contains numerous plant pathogens, including two species blamed for causing citrus shoot dieback symptoms in California since 2012. Tissue samples collected from ‘Bingo’ trees in growers’ fields displaying twig dieback generated many isolates of *Colletotrichum* fungi, 13 of which were purified, and represent three species. Next, the team attempted — unsuccessfully — to induce dieback in healthy, greenhouse-grown citrus trees by inoculating them with a solution containing all 13 *Colletotrichum* isolates. The results were not entirely conclusive in regard to wounding but the researchers believe that dieback could be the result of an opportunistic infection that develops after a tree experiences severe physical damage or a physiological response to wounding, which can happen during normal field operations. Further experiments will help resolve this question.

**Programs held throughout the year included:**

- Florida Citrus Growers’ Institute
- Polk County, Highlands County and Arcadia Safety Days
- Flavor Summit
- CRDF Rootstock Field Day
- CUPS Field Day
- Highlands County Citrus Growers’ Workshop
- Citrus Insect Management Workshop
- Citrus Nursery Workshop
- Citrus Nutrition Day and Field Tour
- Citrus Youth Day
- 33 publications produced in referred and non-refereed outlets

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