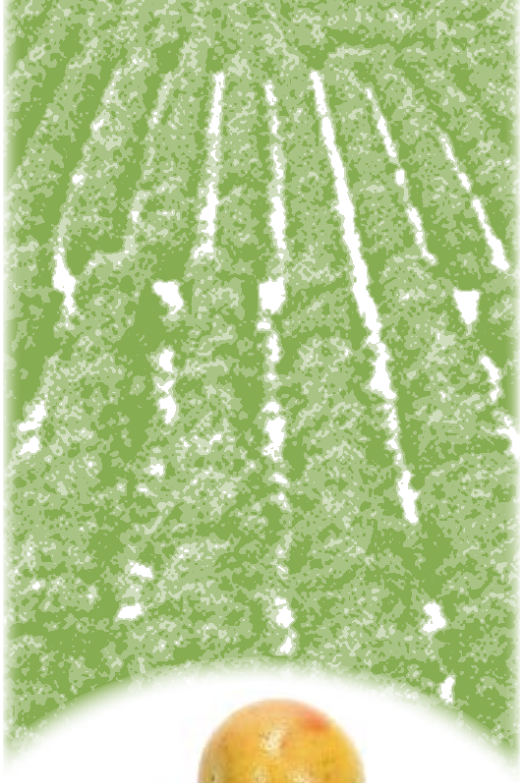
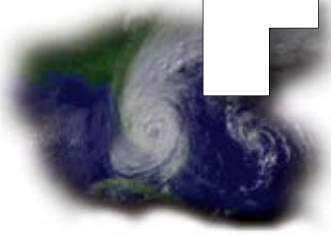
CITRUS SQUEEZE



UF Mobilizes Its Agricultural Scientists To Defend Florida's $9.3 Billion Citrus Industry Against Disease

By Chuck Woods and Tom Nordlie



Florida sacrificed more than 11 million citrus trees over the last 10 years in a desperate struggle to keep citrus canker from spreading, but all of that effort was wiped out in just a few short hours last October when Hurricane Wilma rampaged through the heart of the state's groves, spreading the bacteria far and wide.

To make matters even worse, canker is no longer the most significant threat to Florida citrus, having relinquished that title to a more destructive disease called citrus greening.

Wilma's impact on the canker eradication program was so complete that in January the U.S. Department of Agriculture announced it would no longer fund removal of trees.

"Hurricane Wilma may have spread the disease to the point where an estimated 168,000 to 220,000 acres of commercial citrus could be infected and exposed to canker," Florida Commissioner of Agriculture and Consumer Services Charles H. Bronson said in a news release on January 11. "This is in addition to the more than 80,000 acres of commercial citrus that was affected by the 2004 hurricanes."

Robin Koestoyo

Hector Solis, a groundskeeper at UF's Indian River Research and Education Center in Fort Pierce, burns grapefruit trees infected with citrus canker in a research grove at the center last July. Workers had to destroy almost all citrus trees at the center, temporarily halting more than two dozen experiments.

NEWS OF AN END TO THE ERADICATION PROGRAM — WHICH IMPACTED COMMERCIAL GROWERS AND BACKYARD GARDENERS ALIKE WITH ITS REQUIREMENT THAT ALL TREES WITHIN 1,900 FEET OF AN INFECTED TREE BE DESTROYED — CALLED FOR THE DEVELOPMENT OF AN ENTIRELY NEW GAME PLAN FOR DEALING WITH THE DISEASE.

News of an end to the eradication program — which impacted commercial growers and backyard gardeners alike with its requirement that all trees within 1,900 feet of an infected tree be destroyed — called for the development of an entirely new game plan for dealing with the disease.

"Up until now, we've had canker research proceeding along several tracks, one oriented toward eradication and others focused on detection, prevention and management practices," says Jimmy Cheek, the University of Florida's senior vice president for agriculture and natural resources. "Since eradication will no longer be the strategy, we need to make sure we're putting our resources where they'll do the most good."

Canker is spread primarily by wind and rain, and causes citrus to develop small brown lesions and trees to produce less fruit. The current canker outbreak was discovered in 1995.

UF experts are working with USDA, representatives of other agencies and the citrus industry to develop a new statewide canker management plan, says Harold Browning, director of UF's Citrus Research and Education Center in Lake Alfred.

"We have been collaborating with citrus researchers in South America for the past 30 years, and we will try some of their canker-suppression strategies," Browning says. "Brazil has a different climate, but their growers have been somewhat successful protecting groves with a combination of windbreaks, copper-based chemical sprays and decontamination procedures for personnel and equipment."

Ensuring the quality of Florida's citrus exports will be easier with the help of genetically modified canker bacteria that glow bright green when examined under special microscopes, says Jim Graham, a soil microbiologist at the Lake Alfred center who has tested a wide range of canker control strategies since 1999.

Decontamination is vital to stopping the spread of citrus canker. For vehicles this includes regular pressure washing and sanitizing with a bactericide and a close inspection of the undercarriage to ensure all plant debris and soil residue have been removed.

Josh Wickham

Brian Scully, director of UF's Indian River Research and Education Center in Fort Pierce, examines a grapefruit tree infected with citrus canker in a grove at the center.

Canker causes citrus to develop small brown lesions.

Along with post-doctoral associate Jaime Cubero, Graham led a research team that modified the bacteria with a gene derived from a species of jellyfish. The glowing microbes are far easier to detect than their normal counterparts, enabling faster, more accurate evaluation of sanitizing procedures.

"To test a sanitizing system, you can apply the bacteria to a test batch of citrus and simply run it through the system," Graham says. "The bacteria glow only if they're alive, so it's easy to spot survivors and determine how well the system's working."

The modified bacteria will also help researchers learn how long canker bacteria survive outside citrus plant tissue, he says. This information will lead to more effective quarantine and grove-care practices to keep canker bacteria under control.

Citrus trees do not contain canker-fighting genes, but they do have genes providing broad-spectrum disease resistance, says Gloria Moore, a UF professor of horticultural sciences. She is trying to understand how citrus trees can be coaxed into expressing those genes more strongly, giving them a better chance of resisting canker and other pathogens.

In another study, Moore and Fred Gmitter, a horticultural sciences professor at the Lake Alfred center, lead a research team that has examined natural canker resistance in the kumquat, a fruiting plant closely related to citrus.

"One of our graduate students has isolated some of the genes that are responsible," says Moore, who has researched canker genetics for the past five years. "By transferring those genes to citrus trees, we may be able to provide canker resistance."

Rice is another plant with disease resistance UF researchers have borrowed for use in citrus, says Jude Grosser, a horticultural sciences professor at the Lake Alfred center. The grain has a gene that provides protection from rice bacterial blight, a disease closely related to citrus canker.

Doctoral student Ahmad Omar, working with Grosser, Graham and UF plant pathology Assistant Professor Wen-Yuan Song transferred the resistance gene to Hamlin orange trees. The first of these trees is being tested in a quarantine facility to determine if it can resist the most common strain of citrus canker bacteria.

If the test proves successful, the trees will be field-tested to evaluate their ability to resist canker and produce fruit in a real-world environment, Grosser says. Eventually they could become the first canker-resistant citrus variety UF makes available to growers.

"Genetics research has great potential to help the citrus industry overcome this threat," Grosser says. "We're confident it will happen, and we've got a running start, thanks to all the

Mariol Amador

Adult Asian citrus psyllid (Diaphorina citri) *and psyllid nymphs feed on young growth of citrus tree, producing waxy excrements.*

Michael Rogers

work that's been done already."

But as bad as canker is, citrus greening has people in the industry even more worried.

"In the long term, the industry can live with and manage the canker problem, but citrus greening is a fatal disease that's an even larger threat to the state's signature crop," says Browning. "In other areas of the world where greening is a problem, it has never been successfully eradicated."

The disease, which slowly weakens and kills all types of citrus trees, causes fruit to become lopsided and taste bitter. Fruit does not develop the desired color, hence the greening name. Although greening poses no health threat to humans, there is no known cure for the disease.

The disease is transmitted by the Asian citrus psyllid (*Diaphorina citri*), a tiny insect that is now widely distributed throughout Florida, and the disease has been found in more than 440 different locations in 11 counties. Browning says it's not practical to eradicate citrus greening, but the spread of the disease can be slowed with an effective integrated pest management, or IPM, program that includes beneficial insects that attack the psyllid and limited use of insecticides.

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— Harold Browning

The introduction of a beneficial wasp was the first step in an expanded IFAS research program to develop a wide range of best management practices to prevent greening from destroying the industry, Browning says.

Marjorie Hoy, a UF professor of entomology and biological control expert, says the psyllid was first detected in two South Florida counties in June 1998. At the time, the psyllid was considered to be a significant pest, and although it did not appear to carry the deadly bacterial disease that causes citrus greening, it made establishment of greening more likely if the disease were introduced.

"When citrus greening started showing up in citrus trees across the state in September 2005, we knew that we had a potential disaster on our hands, and that the psyllid was carrying and transmitting the deadly disease," Hoy says.

In an attempt to reduce populations of the Asian citrus psyllid, Hoy and Ru Nguyen, an entomologist with the Florida Department of Agriculture and Consumer Services, imported two natural enemies of the psyllid from Taiwan and Thailand.

Asian citrus psyllid nymphs parasitized by a beneficial wasp. Note the exit holes made by the parasitoid.

Gretchen Baut

Entomology Assistant Professor Michael Rogers (left) and plant pathology Professor Ron Brlansky check citrus trees for presence of Asian citrus psyllid. Brlansky says early symptoms of citrus greening are hard to distinguish from other more common problems, like nutritional deficiencies.

After evaluating the parasitic wasps under quarantine conditions to make sure they would be effective against the psyllid and not harm the environment, they began releasing the biological controls about six years ago.

"One of the beneficial wasps (*Tamarixia radiata*) is now widely established throughout Florida, feeding on the psyllids and reducing their population by as much as 80 percent in some locations between August and November," Hoy says. "We're also relying on naturally occurring predacious insects such as lady beetles, lacewings and spiders that consume more than 90 percent of psyllid eggs and nymphs."

Unfortunately, even one psyllid can transmit greening disease, so biological control cannot be the only tool in managing greening. Any control will require a holistic approach, Hoy says.

"Management tools that are developed should be compatible with these and other natural enemies that suppress citrus pests such as mites, whiteflies, scale insects, leafminers and mealybugs," Hoy says. "Indiscriminate killing of their natural enemies could produce serious pest outbreaks."

What complicates control of citrus greening is the fact that symptoms don't begin to show up in trees until several years after the trees are infected by the psyllid insects, says Ron Brlansky, a professor of plant pathology at UF's Lake Alfred center.

"Lack of early detection of the systemic bacterial disease is a major problem for the citrus industry," he says. "Once the symptoms show up, it's too late to save the tree."

Brlansky says early symptoms such as leaf mottling and yellow discoloration may be mistaken for other problems such as nutritional deficiencies, and laboratory tests are needed to determine if greening is the problem. The disease can also be

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— Marjorie Hoy

Thomas Wright

Entomology Professor Marjorie Hoy examines a citrus tree attacked by the Asian citrus psyllid, which carries the citrus greening bacteria. To reduce populations of the pest, Hoy helped introduce a beneficial wasp from Asia that attacks the psyllid. Citrus greening slowly weakens and kills all types of citrus trees. It causes fruit to become lopsided and taste bitter. Fruit does not develop the desired color, hence the greening name. Early symptoms such as leaf mottling and yellow discoloration (inset) may be mistaken for other problems such as nutritional deficiencies.

identified by cutting open small and poorly colored fruit and looking for aborted seeds.

UF researchers plan to attack the citrus greening problem in three ways: by developing best management practices for the bacterial disease, improving diagnostic methods and testing the effectiveness of systemic insecticides to stop transmission of the disease by the psyllids.

Brlansky is working with Michael Rogers, an assistant professor of entomology at the Lake Alfred center, and Vern Damsteegt, a plant pathologist at USDA's Foreign Disease and Weed Science Research Unit in Fort Detrick, Md., to evaluate the ability of systemic insecticides to reduce transmission of the disease by psyllids. The Maryland quarantine facility was selected because it is far from commercial citrus in Florida.

Unlike broad-spectrum insecticides that are applied to the foliage of citrus trees, soil-applied systemic insecticides are less likely to impact other beneficial insects that control citrus pests in existing biological control programs, Rogers says.

"Recent results in our field trials have demonstrated that soil-applied systemic insecticides can reduce psyllid populations on mature citrus trees and provide a significantly longer period of control than foliar applications," he says. "These research projects will allow us to manage psyllids with fewer pesticide applications than growers use in other regions of the world where greening is a problem."

The effectiveness of the beneficial wasp in controlling the Asian citrus psyllid is being evaluated by Rogers in cooperation with Phil Stansly, a professor of entomology at UF's Southwest Florida Research and Education Center in Immokalee, and David Hall, an entomologist at USDA's Horticultural Research Laboratory in Fort Pierce.

With the help of participating growers, the study will identify citrus production areas where the beneficial wasp is established and determine when it is providing effective biological control of the psyllid and when broad-spectrum insecticides should not be used. The wasp will be released in groves where the biological control is not yet established.

Tom Spreen, professor and chair of UF's Department of Food and Resource Economics, predicts citrus canker and greening will reduce the volume of fruit produced in Florida over the next 15 years, and the state may never return to the level of fruit harvested in 2003, before hurricanes spread canker throughout South Florida.

Because of canker, 62 percent of the nursery trees in the state have been destroyed, severely limiting the acreage in groves that can be replanted over the next three years, Spreen says. The presence of canker and greening will also require new greenhouse investments and management systems to ensure disease-free nursery trees.

"However, growing world demand for Florida's high-quality citrus is expected to help boost prices at all levels," Spreen says. "In other words, higher prices should offset lower production volume."

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Harold Browning (left), UF's statewide coordinator for citrus programs, checks citrus tree health with Jim Graham, a UF professor of soil and water science, in Lake Alfred.