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Prescription for Curing Citrus Greening



TIM GOTTWALD (D2938-1)

Huanglongbing (HLB), or citrus greening, is the most serious threat to the Florida citrus industry in its history and is costing millions of dollars each year. Working with the Florida Department of Agriculture and Consumer Services (FDACS), Yongping Duan and his Agricultural Research Service colleagues in Fort Pierce, Florida, have found a formula for curbing HLB, offering the industry a glimmer of hope.

Duan has published details of work showing that heating potted citrus seedlings in greenhouses kills off the HLB bacterium and can rid the seedlings of citrus greening symptoms. Monitoring efforts show that the benefit can last for at least 2 years.

In a separate field trial, Duan has also found that heating HLB-infected trees in the sun by encasing them in plastic “tents” can prolong their productivity. Results of the field trials have yet to be published, but Duan says heating trees in solar tents may offer relief to growers whose citrus

groves are being devastated. “We can’t guarantee 100-percent elimination, but it can keep production up for longer periods,” Duan says.

When a citrus tree is infected with the HLB bacterium, the pathogen resides inside the tree’s phloem tissues and blocks the passage of nutrients through its vascular system, making the tree unproductive. Infected trees can survive for 3 to 5 years, but fruit that doesn’t fall to the ground prematurely is often misshapen and sometimes will only partially ripen, making it unmarketable. There is no known cure for HLB and no commercially viable, effective treatments. It remains a threat not only to the citrus industry in Florida, where it was discovered in 2005, but to citrus-producing states nationwide.

Following heat treatment in plastic tents (shown in photo at top of page 5), these Huanglongbing-infected orange trees appear nearly symptom free and productive.



SCOTT BAUER (K11953-1)

Left: Orange tree leaves with some symptoms of Huanglongbing, or citrus greening, for which there is no known cure or commercially viable treatment.

Three Temperature Settings, Same Results

In the greenhouse experiments, Duan and his ARS colleagues Michele Hoffman, Melissa Doud, David Hall, and Ed Stover, along with FDACS scientists, exposed 30 HLB-infected citrus seedlings to different levels of heat in growth chambers for periods ranging from 2 days to 10 days. The seedlings were about 2.5 years old, about 2 feet in height, and were growing in



Apply Heat and Wait



1-gallon containers. They were divided into three groups and heated to 104°F, 107°F, or 113°F. Fluorescent lamps provided light for 12-hour “days” and were turned off for 12-hour “nights.”

MARCO PITINO (D2935-1)



For comparison, the researchers also applied the heat treatments to citrus budwood and periwinkle, which is also susceptible to HLB. They used PCR technology, which amplified the pathogen’s DNA, to measure the HLB pathogen levels in the trees, budwood, and periwinkle. Infection levels were measured a week before heat treatments began and again 30, 60, and 270 days after they ended.

The researchers quickly learned that constant exposure to temperatures of 113°F or higher would defoliate citrus seedlings. But if they interrupted the steady onslaught of intense heat by dropping temperatures down to about 80°F for at least 5 hours each day, the leaves stayed alive.

Results from the greenhouse tests, published in the journal *Phytopathology*, also showed that exposing citrus seedlings to a minimum of 48 hours of temperatures of 104°F to 107°F significantly reduced, and often eliminated, HLB infection. All of the heat treatments were equally effective, regardless of temperatures and exposure times. The researchers continued to test the

ARS plant pathologist Yongping Duan (left) and postdoctoral assistant Melissa Doud examine a tree that was previously under a tent (like the one on the left) for heat treatment to combat citrus greening. The technique significantly reduces disease symptoms and improves tree productivity.

seedlings, and after 2 years of heat treatments, they have remained free of HLB.

“This application would be useful for nurseries and greenhouses and rescue of germplasm that’s been infected,” Duan says.

By contrast, exposing newly grafted budwood to alternating temperatures of 102°F and 86°F for up to 4 months did not reliably cure it. The heat controlled the HLB in periwinkle, but the periwinkle plants were more heat tolerant than the citrus trees and required more prolonged heat for infection levels to be reduced.

Heating Trees in Tents

Another approach to controlling HLB damage may have wider implications by prolonging the productivity of full-grown citrus-producing trees. Florida citrus



SCOTT BAUER (K7226-29)

grower David McKenzie, working with Duan, has been encasing citrus trees in opaque, plastic PVC “tents” to heat them up for about a week, then removing the tents and trimming off the top 10 or 12 inches of the trees that have been “browned up” by the solar heat.

The results have been striking. Within short periods of time, leaves stunted by HLB begin to flourish, and by the time the fruit is ready for harvest, its quality is noticeably improved.

“The flush [leaf growth] after the tents are removed is phenomenal. The leaves start to flush about 2 to 4 weeks after the tent is removed, and that flush will peak after about 6 weeks,” McKenzie says.

McKenzie has been using the tents for about a year and a half, applying them from April to September. He has covered about 1,000 of his 130,000 trees, working in alternating 20-acre blocks and tenting about 5 trees at a time in each block. He selects trees with moderate HLB symptoms (smaller, shriveled fruit and stunted leaves) that are about 3 to 6 years old and 6 feet high. He uses cinder blocks to hold the tents in place and positions the tents so their tops are near the tops of the trees and they drape closely around the tree circumference. That way, by mid afternoon the heat in the tents

reaches about 125°F near the treetops and about 110°F near the base.

“Once trees reach a certain size, maybe to where they have a 25-foot circumference, that’s about the maximum size for using the tent. What is important is for the top of the tent to be close to the top of the tree, so you have heat at the top,” McKenzie says.

Tents can be reused, and McKenzie estimates that with labor, the system costs about \$45 per tent. He says the results are worth the effort.

“We’re finding that the trees we tented last year don’t need to be tented this year. Trees with major symptoms before the treatment have minor symptoms after treatment, and the trees are producing normal fruit where they were producing small fruit before,” McKenzie says.

As with the potted citrus, Duan is unsure about the specific biological causes underlying the results. HLB is a systemic disease, and eliminating it from a tree generally requires eliminating it from the roots. The heat doesn’t entirely kill off the HLB in the tree, but it seems to weaken the infection process and prolong the tree’s productive life.

“It works better if the infection is in its early stages and the bacteria have not yet reached the plant root,” Duan says.

The results of Duan’s field trial at McKenzie’s groves are not yet published. But Duan is promoting them along with the growth chamber results in scientific conferences and meetings with growers and nursery operators. The work has been partially funded by FDACS and the Citrus Research and Development Foundation.

Growers are beginning to consider the approaches, where practical, and McKenzie is enthusiastic about the results.

“Do I think it works? Absolutely I do. It’s encouraging. It makes me think that with all the damage we’re seeing from citrus greening in Florida, we’re staying in the game,” McKenzie says.—By **Dennis O’Brien, ARS.**

This research is part of Plant Diseases, an ARS national program (#303) described at www.nps.ars.usda.gov.

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Trees infected with citrus greening, but not treated with heat, have obvious disease symptoms and reduced productivity.



MARCO PITINO (D2936-1)