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Made in the shade

Feral citrus growing in natural hammocks reveals insights about production and HLB.

By Christopher Vincent and Anirban Guha

Would you rather go outside in August and stand for a few hours in the sun or in the shade? It turns out citrus prefers the shade, too.

In the past two years, we have been researching the health of citrus growing in natural hammock areas. We have learned that the natural forest environment is good for citrus. The forest keeps psyllid pressure low and improves the photosynthetic health of citrus leaves.

We ventured out of the typical commercial grove and into the woods following conversations with growers. Some people noticed very healthy-looking feral citrus trees growing in hammocks right next to commercial groves. Others observed that trees in commercial groves looked healthier when growing on the edges of groves where border trees had grown very tall. While out at the Circle B Bar Reserve in Lakeland, we noticed some healthy grapefruit trees growing near the hammock trail. This was surprising to us as most citrus trees in a nearby grove were suffering from HLB. So, we decided to study the Circle B trees in-depth, to take a closer look at their health and HLB infection status.

We identified 60 grapefruit trees growing under varying degrees of forest shade cover, with different forest species providing that shade, including laurel oaks, live oaks, sabal palmettos and some deciduous trees. Nabil Killiny's group helped us with qPCR-based diagnostics for the detection of *Candidatus* Liberibacter asiaticus (*C*Las) while Lauren Diepenbrock's group put out sticky traps to capture Asian citrus psyllids. We measured several leaf traits associated with photosynthesis, as well as starch content to diagnose HLB symptoms. All trees were mature and fruiting.

NO PSYLLIDS; FEW HLB INFECTIONS

To our surprise, only thee trees tested positive for infection with *C*Las. How did so few trees become infected? After four visits to each tree, in which

we inspected the current flush on every tree for the Asian citrus psyllid, and after two weeks of yellow sticky trap surveys in May, not a single psyllid was detected. Of the trees that were infected, none of them showed the characteristic physiological symptoms of HLB. Infected plants had no reduction in photosynthetic performance nor any abnormal accumulation of starch content.

The forest shade cover improved the photochemical performance index, a measure of photosynthetic health, of the grapefruit trees. In our study, compared to oak shade cover, the non-oak shade significantly improved the photosynthetic performance of citrus leaves.

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Adult psyllids use light reflecting off leaves and young shoot and leaf odor to locate their favorite food, the citrus plants. When the plant is in the shade, less light reflects off the leaves, making it harder for the psyllid to find its host. Further, different co-existing plants in the forest can also modulate host plant odor and disorient the psyllids. This may help explain why in our study most of the citrus trees remained non-infected, even though there was a fully infected grove only a half-mile away and two others less than one mile away in other directions.

Not only were there fewer infections, but the infected plants did not show symptoms. We think this is because the existing shade cover created a better environment and protected the citrus plants from additional stressors like high light, which heats leaves and increases their demand for water. These stresses can intensify disease symptoms.

Results from our forest study do not translate directly to yield. The

grapefruit trees in the woods were healthy, but not necessarily productive on a horticultural scale. For example, citrus trees flower more with sufficient sunlight, so intense shade cover will lead to healthy plants that do not flower often.

What we can learn from the forest ecosystem is that shade is one of the factors which may help reduce HLB transmission and symptoms and improve citrus physiological performance. This is not too surprising, considering that citrus' natural habitat is under the forest canopy.

Christopher Vincent and Lauren Diepenbrock inspect a grapefruit tree growing under forest canopy at Circle B Bar Reserve in Lakeland, Florida.

PUTTING SHADE TO THE TEST

To translate this natural phenomenon into a potentially useful horticultural practice, we decided to test shade in a horticultural setting on citrus trees that are mature and already infected by HLB. We are now one and a half years into a multi-year field trial of varying degrees of shade on sweet oranges. We placed different permanent shade nets over trees that block 70, 50 and 30 percent of sunlight. Full-sun controls were also included.

We are testing how different levels of shade modify plant physiology, bacterial titers and plant growth and productivity compared to non-shade. So far, we have found that shade helps keep the leaf temperatures cooler, helps avoid water stress and increases yield. With 30 percent shade, yield nearly tripled after one year of treatment. The results from the next harvest will help us understand how these treatments are affecting flowering and fruiting and whether the increased yields can be sustained. If

Shade structures cover Hamlin sweet orange trees in a study at the Citrus Research and Education Center in Lake Alfred, Florida.

they can, the next step will be to assess how shade could be incorporated into existing citrus production practices.

One useful shading practice that is available right now is the use of particle films. We see increase in growth and yield when citrus plants are treated with particle films. These films camouflage the plants from Asian citrus psyllid, and they shade the leaves of citrus plants, cooling them and allowing them to grow more, even when infected with HLB.

The shaded environment is physiologically better for citrus in Florida, and it greatly reduces the HLB disease cycle. We hope that as we continue to learn more, we will be able to provide additional horticultural approaches to use shade for the benefit of growers.

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