method for limiting insect populations in an ACPS. The additional pest control required per acre per year in an ACPS may seem uneconomical but in reality due to the compression in space (more trees per acre) and time (higher growth rates) achieved, the costs of pest control required to bring a new ACPS grove into production in half the normal time may even be lower than in a conventional production system.

In summary, ACPS is used to grow citrus trees quicker to “beat the disease cycle,” and with fewer nonrenewable resources than conventional production methods. Additionally, ACPS aims to minimize environmental stresses to the trees, particularly transient nutrient and water stresses which are not normally noticeable but which can reduce growth rates and may lower a plant’s resistance to disease.

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*Can supplemental nutrient applications alleviate symptoms of HLB and improve productivity? — Tim Spann*

Everyone is well aware of the confusion that can exist in trying to distinguish visible symptoms of citrus greening disease (Huanglongbing, HLB) from nutrient deficiency symptoms. In fact, many papers describing the leaf symptoms of greening will often describe them as nutrient deficiency-like. In recent reviews on greening, Jose Bové and John da Graça both indicate that as the disease progresses in a tree, symptoms of Zinc (Zn) deficiency will develop. However, visible Zn deficiency alone is not a good indicator of citrus greening infection since Zn deficiency may occur in uninfected trees and is quite distinguishable from the typical asymmetrical blotchy mottle of greening leaves associated with high leaf starch. This article discusses our current thinking on the citrus greening/leaf nutrition connection and the research being done to further our understanding of this topic.

Other micronutrient deficiencies, particularly Boron (B), can also cause symptoms that are frequently seen on greening infected trees. In a paper from 1930, A.R.C. Haas described citrus trees with corking and splitting of leaf veins, abscission of leaves, and accumulation of excessive amounts of carbohydrates in affected leaves. One could easily believe he was describing greening symptoms, but he was actually describing B deficiency.

The visible connection between nutrient deficiency and citrus greening is not new. During the 1970s, two separate studies showed that greening symptomatic leaves had lower levels of Calcium (Ca), Magnesium (Mg), and Zn compared to asymptomatic leaves, and potassium (K) increased in symptomatic leaves. Recent studies in Florida by a number of UF/IFAS researchers have confirmed these nutrient deficiencies in greening infected trees in Florida. However, it has also been determined that a number of these deficiencies may be artifacts of the analysis because of the high levels of starch that accumulate in the leaves of HLB-infected trees.

When the analyses are corrected for the high levels of starch, the changes in K, Ca, Mg, and B associated with greening infection are real, and show up consistently across HLB infected groves. Changes in Zn are not consistent and appear to be due to dilution caused by the high starch content of HLB infection. It is likely that these changes in K, Ca, Mg, and B are from restrictions of nutrient uptake, transport, or metabolism induced by HLB infection, based on the role these nutrients play in plant physiology. These consistent changes in specific nutrients lead one to question whether remedial foliar applications of these nutrients can reduce the affects of HLB, and prolong tree health and productivity.

Anecdotal evidence from one commercial citrus grove in southwest Florida suggests that remedial nutrient applications may sustain symptoms of HLB-infected trees in the short-term. IFAS is currently conducting at least four field trials in various locations around the state to attempt to replicate those results.
and determine exactly what nutrients/products are effective, and how tree health, growth, yield, bacterial titers, and disease spread are affected. None of these trials is complete at this time, so a definitive answer is still down the road. In addition to field trials, a detailed greenhouse trial is underway to determine the effects of specific plant nutrients on HLB infection under controlled conditions.

Yield data collected from the southwest Florida grove last year indicates that infected trees produce smaller fruit compared with healthy trees and that total yield on a per tree basis is reduced. However, almost without exception, the infected trees sampled were smaller than the healthy trees, and when yield (total weight of fruit) was expressed on a canopy volume basis to correct for tree size, infected trees had a similar yield to healthy trees. This indicates that yield loss due to HLB infection may be a result of poor tree growth and, thus, less fruit producing wood. However, since we do not have data from when the trees became infected, it is possible that the infected trees were smaller and weaker to begin with. This leads to the question of whether particular trees are more susceptible to infection, either because they are more attractive to psyllids or because they are weaker, compared to other trees.

Questions that must be answered about this strategy for dealing with HLB are numerous. First and foremost, does HLB spread more quickly in a grove where infected trees are managed and not removed compared to a grove with tree removal, assuming that psyllid control is equivalent in the two situations? That leads to questions about whether psyllids are more attracted to infected trees compared to healthy trees. Additionally, do remedial foliar nutrient applications alter some aspect of tree physiology that in turn affects psyllid feeding preferences? These are just a few critical questions that researchers must work towards answering in order to determine if a plant nutrition strategy is a viable option for managing HLB in Florida citrus.

One thing that is for certain, regardless of the management approach you take in your grove: psyllid control is critical. All management strategies for this disease are doomed to fail if psyllid populations are not controlled to every extent possible.

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Research update on new tools being investigated for citrus leafminer control
— Lukasz Stelinski

Research has continued on the development of effective control tools for the citrus leafminer (CLM). One of the main thrusts of this project has been to develop pheromone based control strategies for this pest that will serve as alternatives to insecticides and that should be comparable or better than insecticides in terms of efficacy and cost. In this area, we have been investigating a pheromone mating disruption technology and a pheromone attract-and-kill technology. Most recently, we developed and evaluated the attract-and-kill formulation, termed MalEx, for control of CLM. MalEx is a viscous paste with UV-protective properties that is dispensed as small (50 µl) droplets using custom-made calibrated pumps. MalEx is manufactured by a company based in New York State called Alpha Scents. The attract-and-kill formulation is applied to tree foliage as small droplets which release pheromone that is highly attractive to males. Attract-and-kill formulations work by attracting insects to small droplets of the formulation. As the pest insects touch the droplets, they obtain a lethal dose of toxicant upon contact and die. A formulation containing the CLM pheromone and 6% permethrin was found to suppress CLM populations in the field. Continuous treatment of 1.2 acre blocks of citrus with MalEx over the course of 112 days reduced larval infestation of new leaf flush by 3.6-7.2 fold. We are currently investigating whether other insecticides may be more effective than permethrin and working to extend the longevity of the formulation. Control of CLM with MalEx should reduce the number of required pesticide sprays for