Figure 1. In a trial at the Southwest Florida Research and Education Center in Immokalee, trees are being grown under individual protective covers.

HLB reduction strategies

By Jawwad Qureshi, Lukasz Stelinski and Fernando Alferez

Management of huanglongbing (HLB) has focused on reducing the vector Asian citrus psyllid (ACP) and improving tree health, thus requiring a multi-pronged approach. Several elements of an HLB management system are either available or under current investigation. Maintenance of clean nursery stock, vector management and tree nutrition are widely implemented, while incorporation of tolerant or resistant varieties and pathogen reduction with bactericides are tactics that continue to be developed. Once in the field, trees are subject to psyllid attack and HLB infection. Strategies to reduce the incidence of this vector-pathogen complex are discussed below.

AVOIDANCE

Citrus Under Protective Screen

Keeping psyllids away from citrus trees is currently the only way of preventing tree infection. Growing citrus under protective screen (CUPS) can effectively exclude psyllids and HLB and has shown potential for high yields of quality fruit compared to standard growing practices. The initial costs of installing and maintaining CUPS are high, but are expected to be offset by maximizing yields and profit when growing for the fresh fruit market.

CUPS is currently the only promising system to produce HLB-free citrus in Florida. Some growers are already establishing CUPS. Pests such as leafminers, mites, thrips and scales are able to enter through the currently used CUPS screens. High humidity inside CUPS may be conducive for development of fungal pathogens responsible for diseases such as greasy spot. Management of these additional pests and pathogens is under investigation to further optimize CUPS technology.

Individual Protective Covers

Protection of young trees from HLB is a challenge in normal groves, and strategies that may exclude the vector and pathogen physically are appealing. Excluding psyllids with individual protective covers (IPCs) of fine netting is a novel physical barrier approach. IPCs are an attractive

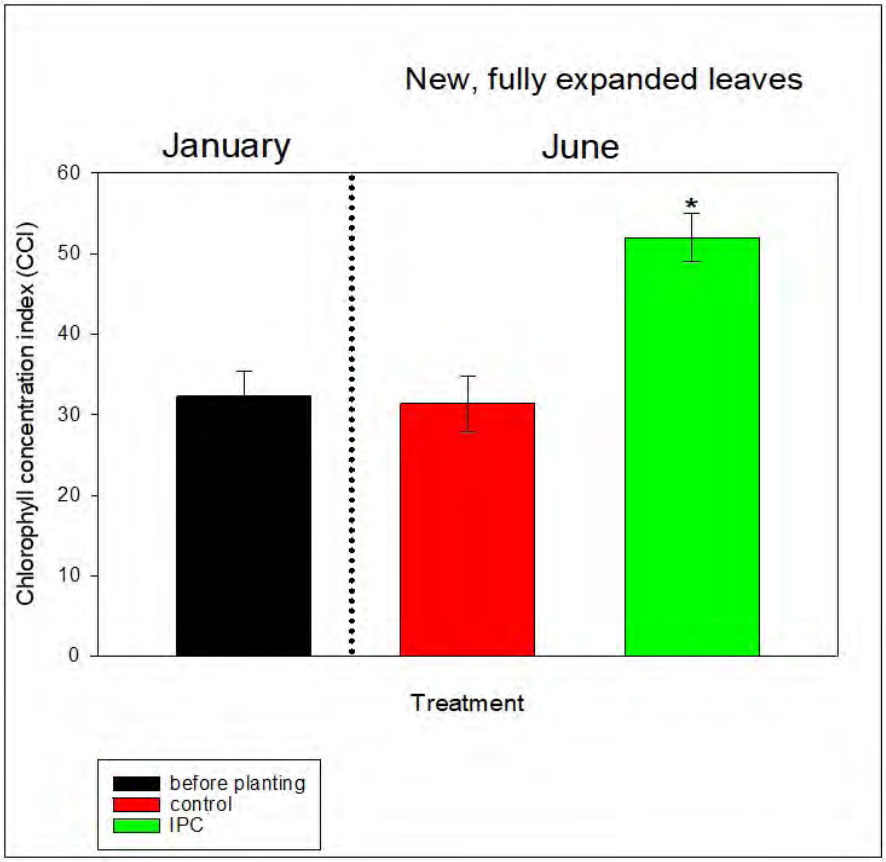

Figure 2. Chlorophyll content in new, fully expanded leaves on 1.5-year-old Valencia trees six months after planting and installation of individual protective covers.

alternative to soil drench and foliar insecticides, which reduce psyllid populations but not sufficiently enough to prevent HLB infection.

IPCs are placed immediately after planting and can typically stay on the tree for up to two years, depending on the canopy size and variety (Figure 1, page 8). In one trial, after nine months, all plants covered with the bags are still HLB-symptom free and tested negative for HLB. Uncovered trees of the same age are already showing symptoms of the disease.

Trees under IPCs flushed one week earlier than their counterparts without IPCs and accumulated significantly more chlorophyll than trees without IPCs (Figure 2). Trees protected from ACP and HLB are starting to show a trend for increased leaf area, as well as greater canopy and trunk diameter compared to those without protection.

IPCs modify the immediate atmosphere around the covered canopy by lowering vapor pressure deficit (VPD). Lowering VPD enables stomata to remain open, which in turn allows

photosynthesis to continue longer every day. This may explain the faster growth observed among trees under covers. This trial is still in progress and will be used to investigate long-term tree health, as well as pest and disease incidence under protective covers.

Another trial conducted using Valencia on sweet orange plants also showed improved plant health under IPCs. However, IPCs were not placed on the trees until two months after they were planted. That window of exposure to psyllids resulted in transmission and establishment of the HLB pathogen in trees.

After about one and a half years, 57 percent of trees receiving delayed installment of IPCs were HLB positive compared to 83 percent without IPCs. Once covered with IPCs, feeding by psyllids stopped and disease progression was slower than in trees that were completely unprotected by IPCs. This is likely the result of reduced re-inoculation of the pathogen by psyllids for plants protected by the physical barrier. This suggests the need for complete protection from psyllids starting right at planting to avoid HLB symptom expression.

Trees under IPCs flushed one week earlier than their counterparts without IPCs and accumulated significantly more chlorophyll than trees without IPCs.

Complementary laboratory experiments in growth chambers have shown that tree decline is greatly accelerated among trees that receive continuous re-inoculation of the pathogen causing HLB compared with those that receive little or no inoculation. Given that re-inoculation appears to accelerate tree decline, applying pesticides or other tactics to reduce the probability of multiple infections is important — even if trees are already infected and expressing HLB symptoms.

The current cost for one IPC is $8.50. The IPCs may reduce the costs associated with chemical treatments used against pests and disease. Protection from HLB in young, non-bearing trees may be useful to extend the productive life of trees, improve health of infected ones, and ultimately provide yield benefits.

TOLERANCE

Development of varieties that are to some degree tolerant or resistant to HLB will provide long-term solutions for this disease. On a similar path, progress continues toward shorter-term solutions by producing tolerant rootstock-scion combinations. These combinations may become infected with the causal pathogen of HLB, but can still produce profitable yields. Large-scale trials are in progress testing some of the HLB-tolerant plant materials.

Use of bactericides to target HLB pathogens in the plant and reduction in vector populations could provide plants with additional support to tolerate disease pressure. For example, yield benefits from managing ACP populations in a grove with high HLB

infection have been demonstrated in South Florida (Stansly et al. 2014, Qureshi and Stansly 2017).

MANAGEMENT

Attempts to reduce vector populations with chemical and biological means have not prevented HLB from spreading across Florida. Incorporation of additional cultural practices and integration of available tools into more robust management systems is still viable.

Metalized Mulch

Growing young plants on metalized polyethylene mulch helps to disorient psyllids from colonizing citrus, reduces HLB incidence and improves yields significantly. Studies have shown that in addition to these advantages, mulch incorporated with drip irrigation and fertigation increased soil moisture, reduced weed pressure and increased tree growth rate. Depending on crop value, the profit from growing on mulch could be sufficient to cover the cost of applying it.

Resistance and Rotation

Protection afforded by soil-applied systemic neonicotinoid (4A mode of action) insecticides was once an effective tool against ACP control in young trees, but this is no longer a given. Due to the extensive use of this insecticide class, psyllids are now showing resistance to this mode of action. Therefore, it is important to rotate this mode of action with foliar sprays in both young and mature trees. Consider using this mode of action as part of a foliar spray rotation in areas where soil drench applications are failing due to resistance.

Insecticides are and will likely remain an important component of psyllid management. Selection of insecticide modes of action and timing their applications based on flush development can improve efficacy results and minimize the chance of resistance development. Details of products recommended for suppression of psyllid populations and other pests are provided in the Florida Citrus Production Guide.

Spray Timing

Limiting the use of broad-spectrum

insecticide sprays to the dormant period when flushing occurs at lower frequencies and beneficial insects are scarce or absent helps to maximize suppression of ACP by targeting overwintering adults (Qureshi and Stansly, 2010). If sprays are timed to target ACP directly prior to egg laying on new feather flush, investment in spray treatments will be maximized. This practice takes advantage of the weak link in the ACP life cycle with the objective of further reducing population before a major spring flush.

ACP has a very high reproductive rate and needs soft developing tissues of young shoots to deposit eggs. Killing most adults during winter when reproductive capacity is most limited helps reduce the probability of significant population spikes when spring growth provides ACP with abundant resources for reproduction.

Other Options

Additional reduction in use of insecticides is possible through rotation with kaolin clays that alter the spectral reflectance of coated leaves and reduce psyllid colonization. Reducing use of broad-spectrum insecticides during the summer or limiting sprays to grove borders where psyllids colonize most, as well as integrating selective insecticides, kaolin clays and oils into rotations during this period can help conserve the impact of beneficial insects (Qureshi and Stansly 2010, 2017).

Biological control is an important component of ACP management. Predators, the parasitoid *Tamarixia radiata* and entomopathogenic fungi all reduce psyllid population growth in the urban and commercial environments. The impact of insect predators and parasitoids can be conserved with judicious use of insecticides.

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Additional reading

Controlling ACP and other pests as critical as ever

http://citrusindustry.net/2017/04/04/controlling-acp-and-other-pests-as-critical-as-ever/

Vector control and foliar nutrition to maintain economic sustainability of bearing citrus in Florida groves affected by huanglongbing

https://doi.org/10.1002/ps.3577

Dormant season foliar sprays of broad-spectrum insecticides: An effective component of integrated management for Diaphorina citri (Hemiptera: Psyllidae) in citrus orchards

https://doi.org/10.1016/j.cropro.2010.04.013