

# Protection of young trees from the Asian citrus psyllid and HLB

By Michael E. Rogers

The ability to bring young trees into production in areas where HLB is present is one of the most important challenges Florida citrus growers must deal with. As citrus trees become unproductive due to diseases, they must be replaced with new trees to ensure long-term economic viability of a grove. This issue has recently become a hot topic of discussion as growers throughout the state have reported that increasing numbers of young trees, both in solid-block plantings and resets within mature groves, are showing symptoms of HLB.

Field trials funded by the Citrus Research & Development Foundation are under way to evaluate the success of different pest management programs that can be used to prevent young trees from becoming infected with the HLB pathogen and bring those trees into production where HLB pressure is high. However, these “real world” field studies will require several years to adequately determine the success or failure of the approach-

es being tested. In the meantime, we must rely on our current knowledge of the tools available for controlling psyllids on young trees. The following is a summary of what is currently known regarding management of psyllids on young trees.

## INSECTICIDE PRODUCTS FOR YOUNG TREE CARE

### Soil-applied systemic insecticides

The group of insecticides that is the most effective for controlling psyllids on young trees is the soil-applied systemic insecticides. The only soil-applied products currently registered for use in citrus that provide effective control of psyllids are all neonicotinoid insecticides; they all have the same mode of action (Table 1). The three labeled products include imidacloprid (Admire Pro 4.6F), thiamethoxam (Platinum 75 SG) and clothianidin (Belay 50 WDG).

All three of these neonicotinoids are highly mobile in the xylem, meaning that when they are applied as a soil-drench around the base of

the tree, they are taken up by the root system and moved via the xylem tissue to the leaves. For trees up to 5 feet in height, these soil-drench applications usually take about two to three weeks after an application is made to move into the leaves to provide control of psyllids. Therefore, **these applications should be made before psyllids are observed feeding on a tree.** Control of psyllid populations typically lasts for six to eight weeks after the application is made. During this window of activity, any new flush produced by the plants will be protected as the insecticide moves via the xylem into the new leaf growth.

Both imidacloprid and thiamethoxam have a full citrus label, meaning they can be applied to young trees bearing fruit which is expected to be harvested. Clothianidin is currently labeled for non-bearing citrus use only, meaning it should not be applied to trees from which fruit will be harvested within 12 months of application.

### Foliar-applied insecticides

There are numerous foliar-applied

**Table 1. Yearly product limits and suggested use rates, based on tree height, for soil-applied neonicotinoid insecticides**

Product	Chemical class (MOA group) <sup>1</sup>	Yearly product limit / A	New Reset (2-3' height)	1-2 years (3-5' height)	3-5+ years (5-9' height)
<b>Admire Pro 4.6F (imidacloprid)<sup>2</sup></b>	Neonicotinoid (4)	14 fl. oz. (0.05 lbs. a.i.)	3.5 fl. oz. / A 0.025 fl. oz. / tree (4 apps) <sup>3</sup>	7 fl. oz. / A 0.05 fl. oz. / tree (2 apps) <sup>3</sup>	14 fl. oz. / A 0.1 fl. oz. / tree (1 app) <sup>3</sup>
<b>Platinum 75 SG (thiamethoxam)</b>	Neonicotinoid (4)	3.67 oz. (0.172 lbs. a.i.)	1.835 oz. / A 0.0131 oz. / tree (2 apps) <sup>3</sup>	1.835 oz. / A 0.0131 oz. / tree (2 apps) <sup>3</sup>	3.67 oz. / A 0.0262 oz. / tree (1 app) <sup>3</sup>
<b>Belay 50 WDG (clothianidin)</b>	Neonicotinoid (4)	12.8 oz. (0.4 lbs. a.i.)	3.2 oz. / A 0.0229 oz. / tree (4 apps) <sup>3</sup>	3.2 oz. / A 0.0229 oz. / tree (4 apps) <sup>3,4</sup>	(Non-bearing only) <sup>4</sup>

<sup>1</sup> Mode of action class for insecticides from the Insecticide Resistance Action Committee (IRAC) mode of action classification.

<sup>2</sup> The per-tree use rate of imidacloprid shown is for the 4.6F formulation. Additional products with varying concentrations of the imidacloprid active ingredient are available (i.e., 1.6F, 2F and 4F). Rate of product applied per tree may need to be adjusted based on formulation used.

<sup>3</sup> Number of applications that can be applied per season using the listed per-tree use rate at a planting density of 140 trees per acre.

<sup>4</sup> Currently, clothianidin is labeled for non-bearing use only.

products with various modes of action available for psyllid control. These include products such as organophosphates, carbamates and pyrethroids as well as some more recently developed modes of action including spinosyn derivatives, tetramic acids, insect growth regulators and others. More information on these products is available in the Florida Citrus Pest Management Guide.

Most foliar-applied insecticides only control psyllids on the leaves that are present at the time the application is made. Thus, psyllids moving into a block from surrounding areas will be able to feed and reproduce on any new leaves produced several days to a week or more after the foliar application was made. For this reason, the duration of pest control provided by foliar-applied insecticides is much shorter when compared to the systemic protection provided by soil-applied insecticides.

The same is true for foliar applications of neonicotinoid insecticides. While neonicotinoids are highly xylem mobile and can provide long-lasting systemic protection when applied as a soil-drench, they have very limited phloem mobility. As a result, when applied as a foliar spray, true systemic movement of the neonicotinoid insecticide from sprayed leaves to new leaves, which requires movement via phloem, is limited. For this reason, soil-applied neonicotinoid applications to young trees provide a much longer duration of protection than foliar sprays of the same product. Thus, for young tree care, neonicotinoid insecticides should be applied only as a soil-drench.

### CAN INSECTICIDES PREVENT YOUNG TREES FROM BECOMING HLB INFECTED?

The short answer is yes ... but only for certain insecticides. Since the HLB pathogen is found only in the phloem of infected citrus, preventing psyllids from feeding on the phloem of plants should prevent pathogen transmission from occurring.

Utilizing an electrical penetration graph monitor, we have been able to conduct in-depth investigations into psyllid feeding to determine whether insecticide applications can prevent psyllids from feeding on citrus phloem before they cause death of the psyllid, and if so, for how long. Of the insecticides tested thus far, the soil-applied neonicotinoids have been

**Table 2. Summary of electrical penetration graph assessment of psyllid feeding behavior to determine ability of insecticide applications to prevent citrus plants from becoming HLB infected via disruption of psyllid phloem-feeding behaviors.**

Product evaluated	Active ingredient	Application method	Duration of psyllid feeding disruption
Admire Pro 4.6F	imidacloprid	Soil drench	At least 6 weeks*
Platinum 75 SG	thiamethoxam	Soil drench	At least 6 weeks*
Belay 50 WDG	clothianidin	Soil drench	At least 6 weeks*
Provado 1.6 F	imidacloprid	Foliar applied	3 weeks
Danitol 2.4 EC	fenpropathrin	Foliar applied	2-3 weeks
Lorsban Advanced	chlorpyrifos	Foliar applied	24 hours
Delegate WG	spinetoram	Foliar applied	24 hours
Movento MPC	spirotetramat	Foliar applied	none

*\*No evaluations of the soil-applied neonicotinoids have been made beyond six weeks.*

found to be the most effective way to prevent phloem feeding by psyllids. Soil applications of neonicotinoids do not leave residues on the leaf surface for an insect to encounter; therefore, the psyllid must insert its mouthparts into the plant and begin feeding in order to contact the insecticide. Despite the initiation of feeding behavior, very shortly after psyllids insert their mouthparts into the plant, they get a “taste” of the insecticide and quickly withdraw their mouthparts. The amount of time spent with their mouthparts in the soil-applied, systemic, neonicotinoid-treated plant is not long enough to make contact with the phloem system of the plant, which usually requires a minimum of one hour of sustained feeding. As a result, the ability of psyllids to successfully infect a healthy citrus plant treated with a soil-applied neonicotinoid is greatly reduced if not totally prevented. The duration of time during which soil applications of neonicotinoids can prevent phloem feeding from occurring has been shown to be at least six weeks (the longest duration tested) for young plants less than 3 feet in height (Table 2). Additional studies are under way to determine how long this feeding disruption lasts on neonicotinoid-treated trees greater than 3 feet in height.

Compared to soil-applied insecticides, the duration of psyllid feeding disruption provided by foliar insecticide applications evaluated to date is very short (Table 2). Just to clarify, here we are not talking about the effectiveness of these prod-

ucts to control psyllids (cause death), but instead are looking at the ability of these insecticide applications to disrupt psyllid feeding behavior quickly enough so that psyllids are not able to reach the phloem and transmit the HLB pathogen prior to the insecticide residue causing death of the psyllid.

All of the foliar products discussed below are valuable tools that can be used to help maintain the overall psyllid population at low levels. Of the broad-spectrum foliar insecticide applications evaluated, the pyrethroid fenpropathrin (Danitol) prevented phloem feeding by psyllids for two to three weeks, whereas the organophosphate chlorpyrifos (Lorsban) only prevented phloem feeding for one day. Little or no disruption of phloem feeding was found for other products with more selective modes of action such as spinetoram (Delegate), which only prevented phloem feeding for 24 hours, and spirotetramat (Movento), which did not provide any disruption of psyllid feeding behavior. Foliar-applied imidacloprid provided the longest-lasting disruption of phloem-feeding behavior of any foliar treatments examined, lasting about three weeks, after which time psyllids were able to feed on the phloem of treated plants. However, compared to soil applications of imidacloprid, the duration of phloem feeding disruption provided was much shorter in duration and thus demonstrates why it is much more valuable to save the use of neonicotinoid products as soil-drench applications for young tree protection.

## APPROACH TO PROTECTING YOUNG TREES

Due to the uncertainty of whether an HLB-infected non-bearing tree can be brought into production, the goal of a young tree care program is to prevent trees from becoming infected with HLB prior to reaching bearing age. The overall grove management program will play an important role in helping to minimize psyllid pressure on young trees. However, psyllids are still likely to fly in from surrounding areas. If these psyllids are carrying the HLB pathogen, uninterrupted feeding on young trees will result in young trees becoming infected with the pathogen.

As discussed above, the best tools we have for protecting young trees from HLB are the soil-applied neonicotinoid insecticides. Because these products are applied to the soil and move through the xylem system to the leaves, as the canopy volume increases, the per-tree rate of product applied must be increased to account for the dilution of product among the greater number of leaves present in larger trees. Table 1 lists the suggested per-tree product use rate based on tree height for the three neonicotinoid insecticides.

An annual plan should be developed for young trees based on the

growing conditions which include planting scenario (solid block vs. resetting) and tree size (age). For newly planted trees approximately 3 feet in height, four applications of both imidacloprid and clothianidin, and two applications of thiamethoxam can be made to young trees each year planted at a density of 140 trees per acre. For trees that have been planted between one and two years, and are 3 to 5 feet in height, two applications of imidacloprid and thiamethoxam, and four applications of clothianidin can be applied. Once trees reach a height of 5 feet, only one application of both imidacloprid and thiamethoxam can be applied. At this point, trees are likely to contain fruit intended for harvest so clothianidin cannot be applied (Table 1).

Generally speaking, all three of these soil-applied neonicotinoids are similar in terms of level and duration of psyllid control provided. However, one point that should be considered is the difference that exists between these products in terms of water solubility. The solubility of soil-applied products can be important because of the potential for leaching out of the root zone following rainfall. Of the three neonic products, clothianidin is the least water soluble, followed by imidacloprid and then thiamethoxam, which is the most water soluble. Thus,

when making a season-long plan for young tree care, positioning the use of more water-soluble products during the traditionally dry times of the year and the less water-soluble products for times when higher amounts of rainfall are likely to occur may help to ensure maximum product uptake and protection of plants.

Table 3 lists examples of season-long programs where soil-drench applications of neonicotinoid are made every six or eight weeks for trees up to 5 feet in height. When developing these examples, products were selected for use at certain times of the year based on their water solubility and potential for significant rainfall events under typical Florida conditions. Additionally, when possible, supplemental foliar sprays with different modes of action should be used between applications of neonicotinoid insecticides to minimize the potential for insecticide resistance development.

## FINAL CONSIDERATIONS

One thing is certain: If you are going to try to protect young trees from becoming infected, particularly where there are a high number of infected psyllids flying in from surrounding areas, you can't rely on foliar sprays alone to get the job done; soil-applied neonicotinoid

**Table 3. Example of season-long programs for managing psyllids on young trees where soil-drench applications are made every eight weeks. A more intensive six-week application schedule is also provided.**

Tree size	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Reset (<3') Every 8 wks		P		A		B		B		A		P		
Reset (<3') Every 6 wks*	P		A		A		B		B	A		A		P
1-2 yr. (3-5') Every 8 wks		P		A		B		B		A		P		
1-2 yr. (3-5') Every 6 wks	P		A		B		B		B	A		P		
3-5 yr. (5-9') bearing				P				A						

A = Admire (imidacloprid); B = Belay (clothianidin); P = Platinum (thiamethoxam). Products are positioned for use at certain times of the year based on water solubility and likelihood for significant rain events.

\* Two additional Belay applications were still possible for the six-week schedule listed for resets less than 3 feet in height.

insecticides must be used as often as the labels will allow. Since it is possible to make up to eight soil-drench applications for trees less than 5 feet in height as shown in Table 3, extra attention needs to be given to preventing pesticide resistance development by psyllids to this important group of insecticides.

Between soil-drench applications with neonicotinoid insecticides, foliar applications of insecticides with different modes of action will help to minimize resistance development. The simplest approach to this might be that in addition to the soil-drench applications, young tree blocks would also be treated with the same spray program being applied to blocks of mature trees, assuming that these sprays do not include foliar neonicotinoid applications. While such an approach greatly increases the management costs for young tree care, failure to provide the best protection possible jeopardizes the considerable investment made in planting new trees.

Given the tools available at this time, planting young trees and bringing them into production in the presence of HLB will be difficult, but not impossible. Past approaches used for young tree care are not likely to provide the level of success desired for protecting young trees from becoming HLB infected. Increased awareness of the pest pressure present in young tree blocks or resets is

needed, and will require additional scouting beyond what has typically been practiced. If either leafminer or psyllid are observed on young trees, those infested trees should be considered to be unprotected. This is particularly true in the case where psyllid nymphs are found developing on a plant. The presence of psyllid nymphs means the plant has been unprotected for at least one to two weeks or more in order for adult psyllids to feed, lay eggs and for nymphs to feed and develop on the plant.

Despite the best attempts at protecting young trees, it is possible that the presence of pests developing on a small number of trees will occur due either to application error or simply uneven uptake of the soil-applied product by the plant root system. If the presence of nymphs is not just isolated to one or two trees and can be found at low levels in multiple locations within a young tree planting, the young tree program being used should be carefully examined to identify any potential weak areas. If it's not already being done, consideration should be given to increasing the intensity of the control program, especially to ensure maximizing the use of soil-applied neonics on young trees to the fullest extent possible.

Once trees are 5 to 9 feet in height (three or more years after planting), use of soil-drench applications is lim-

ited to one application each of imidacloprid and thiamethoxam due to the larger canopy volume (see Table 1). In most cases, clothianidin cannot be applied to trees greater than 5 feet in height because of the non-bearing use label. It is possible that clothianidin may receive a full citrus label by 2013. If that does indeed occur, then up to three soil-drench applications per year may be possible on trees that are 5 to 9 feet in height. However, three soil-drench applications will not provide the season-long protection that can be provided currently for trees less than 5 feet in height. Given the current pesticide options available, the ideal situation would be an increase in the labeled yearly use rate of these products to allow more applications to be made to trees 5 to 9 feet in height. Since this is currently not an option, protecting such intermediate-sized trees is best achieved by maintaining the overall psyllid population at as low a level as possible. The most effective approach to achieving this goal is through the collaborative efforts of growers participating in citrus health management areas (CHMAs). Visit [www.fchma.org](http://www.fchma.org) if you are currently not involved in a CHMA in your area and want to learn more.

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