General pest management considerations

By Michael E. Rogers

Responses to greening and its vectors have modified pest management programs

Changes in pest management needs in response to the threat of citrus greening disease and the need to control the insect vector, the Asian citrus psyllid, have resulted in drastic modifications to citrus pest management programs. The increased use of insecticides for psyllid control will result not only in increased costs, but also creation of other pest problems due to disruption of established biological control. Developing an overall pest management program with psyllid control as the primary focus is complicated by a number of additional factors such as:

- which insecticide to use and when;
- what times of the year is psyllid control most important for reducing disease spread;
- and how can the spread of psyllids between groves be minimized?

The following is a general discussion of these issues in terms of developing an overall citrus pest management program.

INSECTICIDE SELECTION

Psyllid control on mature trees is best accomplished by using broad-spectrum insecticides to control the adult psyllids before populations begin to increase on new flush. Use of selective insecticides such as growth regulators and petroleum oils when new flush is present provide control of only a portion of the immature psyllids and fail to control the adult psyllids which will continue to lay eggs. If those adults psyllids are infected with the greening pathogen, they may infect new trees as well. These more selective

Table 1. List of insecticides and miticides recommended for use in the Florida Citrus Management Guide and their effects on different pests and beneficial insects (Revised January 2008)

Pesticide active ingredient	Target pest								Effects on beneficial insects
	Mode of Action'	Psyllid	Leafminer	Rust Mites	Spider Mites	Root Weevil Adults	Scale Insects	Mealybugs	
Abamectin + oil	6	++	+++,R	+++,R	+	+ (oil)	+ (oil)	+ (oil)	medium
Acetamiprid	4	-	+++,R	-	-	?	+	++	medium
Aldicarb	1A	+++,R	-	+++,R	+++	-	-	-	low
Carbaryl	1A	+++,R	-	+	?	+++,R	+++,R	+	high
Chlorpyrifos	1B	+++,R	+	+	-	+	+++,R	+++,R	high
Diflubenzuron	15	++	+++,R	+++,R	-	+++,R	-	-	low
Dimethoate	1B	+++	-	-	-	?	+++,R	+	high
Fenbutatin oxide	12	-	-	+++,R	+++,R	-	-	-	low
Fenpropathrin	3	+++,R	?	+	+	+++,R	-	+	high
Imidacloprid (soil appl., nonbearing)	4	+++,R	+++,R	-	-	+	++	+	low
Imidacloprid (foliar application)	4	+++,R	+	-	-	-	++	+	medium
Petroleum oil	NR	+	++,R	++,R	++	+ (eggs)	++,R	+	low
Pyridaben	21	-	?	++	+++,R	-	-	-	high
Spinosad	5	-	+++,R	-	-	-	-	-	low
Spinetoram		?	+++,R	?	?	?	?	?	low
Spirodiclofen	23	-	-	+++,R	+++,R	?	-	-	low
Sulfur	NR	-	-	+++,R	+++	-	?	?	High

' Mode of action class for citrus pesticides from the Insecticide Resistance Action Committee; NR = no resistance potential, R=product recommendation for control of pest in Florida Citrus Pest Management Guide.
{+++} = good control of pest
{++} = short-term control of pest
{+} = low levels of pest suppression;
{-} = no observed control of pest
{?} = insufficient data available

Table 2. Imidacloprid soil drench rates for solid plantings of nonbearing citrus.

Tree Height	Rate Product/ A*	Applications per season	Ounces per tree	Trees per ounce
Imidacloprid 2F				
2 ft – 4 ft	8 fl oz	4	0.057 fl oz	17.5 trees
4 ft – 6 ft	16 fl oz	2	0.114 fl oz	8.77 trees
Imidacloprid 4.6F (Admire PRO)				
2 ft – 4 ft	3.5 fl oz	4	0.025 fl oz	40 trees
4 ft – 6 ft	7 fl oz	2	0.05 fl oz	20 trees

**Rates based on 140 trees per acre.*

Table 3. Example plan for psyllid control in solid blocks of young citrus trees.

	Tree Size			
Month	**2' - 4'**	**2' - 4'**	**4' - 6'**	**4' - 6'**
January	aldicarb	imidacloprid	aldicarb	
February				imidacloprid
March	imidacloprid	imidacloprid	foliar	
April			imidacloprid	foliar
May	imidacloprid		imidacloprid	imidacloprid
June			foliar	
July	imidacloprid	foliar	foliar	foliar
August		imidacloprid	imidacloprid	foliar
September	imidacloprid			foliar
October		foliar	foliar	foliar
November	foliar			
December		foliar	foliar	foliar

Rates of imidacloprid are based on tree size (see Table 2)
Foliar sprays are suggested 8 weeks after application of soil applied systemic products when control is expected to diminish.
****Supplemental foliar sprays should be used between imidacloprid applications as needed to control localized infestations of psyllids and to minimize the potential for development of insecticide resistance.*

Table 4. Restricted Entry Interval (REI) and Pre-Harvest Interval (PHI) for products currently recommended for psyllid control

Active ingredient	Restricted entry interval (REI)	Pre-harvest interval (PHI)
Aldicarb	48 hours	0; 30 days lemons
Carbaryl	12 hours	5 days
Chlorpyrifos	5 days	21 days
Dimethoate	48 hours	15 days*
Fenpropathrin	24 hours	1 day
Imidacloprid	12 hours	0

**based on PHI listed on Cheminova Dimethoate 4E 2 (ee) Recommendation for Asian citrus psyllid control.*
Always check label for specific product details.

products do have a use for psyllid control when looking at the overall pest management program. There will be situations when other pests, such as rust mites and leafminer, need to be controlled. Using one of these selective products that provide effective control of another target pest will also provide some added benefit to psyllid control. A list of all the products currently recommended for use in the Florida Citrus Pest Management Guide and their expected level of control is provided in Table 1.

The main approach to psyllid control on young trees is the use of soil-applied systemic insecticides. Currently the only two effective options available are aldicarb and imidacloprid. Imidacloprid applications are limited to 0.5lb a.i./A per growing season, thus constraining the number of imidacloprid soil-applications that can be made to blocks of young trees in a season. However, rates can be adjusted based on tree size to allow 2 to 4 applications per season (Table 2). Soil drenches of imidacloprid provide about eight weeks of control of both psyllids and the citrus leafminer, which facilitates canker infection. As control provided by imidacloprid begins to fail and hot spots of psyllids and/or leafminer are noticed in blocks of young trees, supplemental foliar sprays should be used on an as-needed basis to keep pests under control prior to the next imidacloprid soil application. Use of supplemental foliar sprays will also help to manage the development of insecticide resistance to imidacloprid by using products with different modes of action.

Aldicarb can also be used for psyllid control on blocks of young trees. However, aldicarb is not likely to be effective on recently planted trees since the root system may not be expanded far enough away from the tree to allow proper product placement by the application equipment. If trees have well-established root systems that allow for effective aldicarb applications, control of psyllids can be expected to last up to 6 to 8 weeks after application. This will save the use of one imidacloprid application early in the season, thus extending the use of imidacloprid later into the year. Examples of how aldicarb and imidacloprid can be used to maximize pest control in blocks of young trees is provided in Table 3.

Another consideration when choosing an insecticide is the grove production practices that will follow the days after application. For example, Pre-Harvest Intervals (PHIs) on a pesticide label specify the amount of time required between application of a product and fruit harvest. In some cases, the PHI can be several weeks and thus restrict the use of a product during the harvesting season. Similarly, Restricted Entry Intervals (REIs) for a given product could keep workers out of a grove for several days. Table 4 lists the REI and PHI for each of the products currently recommended for psyllid control. Consideration should be given to both of these factors during the planning of pest management programs.

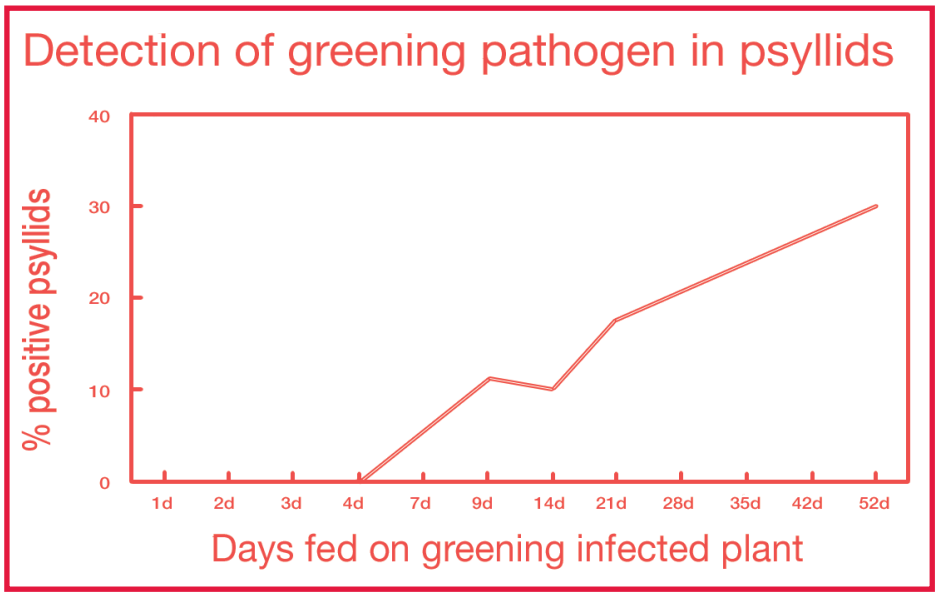

Fig. 1. Percentage of healthy adult psyllids testing positive for the presence of the greening pathogen after feeding on greening infected plants over an increasing period of time.

WHEN SHOULD PSYLLIDS BE CONTROLLED?

Research is under way to determine if there are certain times of the year when psyllids are more likely to be carrying and transmitting the greening pathogen to healthy trees. Ideally, if certain months or seasons were known to increase the risk for disease spread, psyllid spray programs could be adjusted to focus more intensively on those periods of highest risk. In the meantime, ongoing UF-IFAS research on psyllid transmission of the greening pathogen has provided some insight as to the best approach for psyllid control based on current knowledge.

Research conducted on psyllid transmission thus far has shown that within the first seven days of feeding on a greening infected plant, less than 10 percent of psyllids test positive for the presence of the greening pathogen and thus are likely capable of transmitting greening. As the feeding time increases over a period of about seven weeks, the percentage of greening infected psyllids increases to about 30 percent (Figure 1). These results suggest that the longer adult psyllids remain uncontrolled in a grove, the greater the chance they will be capable of transmitting greening if they had been feeding on an infected tree.

During the winter months, adult psyllids can survive for more than 80 days feeding on the underside of mature leaves. If overwintering psyllids were feeding on a greening infected tree during this time, a large number of those psyllids will likely be capable of transmitting the greening pathogen when they move to infest new trees once the first leaf flush of the year is produced. Thus, controlling overwintering psyllids before they move to new trees in response to flushing may help to minimize disease spread early in the season.

In addition to minimizing early-season disease spread, controlling overwintering adult psyllids will result in significantly reduced psyllid numbers on the spring and early summer flushes. While this may result in lower psyllid populations, there is still the risk that those remaining psyllids will spread greening to healthy trees. While elimination of all psyllids in a grove is not possible, continuing to control them throughout the year will maintain psyllid populations at low levels. This will also reduce the longevity of adult psyllids, which may in turn decrease the likelihood that they will acquire and spread greening. If such an approach to psyllid control is successful in reducing the number of infected psyllids within a grove, then the biggest risk for new infections would be from psyllids moving in from surrounding groves.

AERIAL APPLICATIONS

Psyllid adults move between blocks of citrus in response to the presence or absence of new flush. As a result, a grove can be sprayed, reducing psyllid populations below detectable levels, only to be reinfested two to three weeks later by psyllids (possibly carrying the greening pathogen) migrating in from surrounding areas where the population went uncontrolled.

One possible approach to psyllid control that may help to alleviate some of the neighboring grove issues is the use of area-wide aerial applications for psyllid management. The rationale for use of aerial sprays for psyllid management is that such applications provide psyllid control to a large amount of grove acreage in a short period of time, thereby minimizing the overall psyllid population within an area. An overall reduction in the psyllid population in a given area will, in turn, result in a reduced amount of psyllids moving between groves. The end result is an increase in time required for psyllid populations to rebuild to high numbers. This reduced population of psyllids may equate to lower levels of disease spread within blocks and between blocks in the treated area.

In two trials conducted to date, aerial applications of Dimethoate 4E and carbaryl (Sevin XLR) were shown to be effective in reducing adult psyllid populations. While there is more to learn about the best use of aerial applications for psyllid control, results obtained thus far suggest such applications would be a cost-effective solution for psyllid control between ground applications, particularly if groups of growers within an area collaborate to conduct aerial spraying at the same time.

DEVELOPING A PEST MANAGEMENT PLAN

Prior to the need to manage citrus greening disease, each grove had an overall production plan to address plant nutrition and control of insects, mites and diseases. These programs may have included nutritional sprays at different times of the year, multiple oil sprays for disease and mite control and insecticide/miticide applications for reoccurring pest problems such as rust mites and root weevils. And let's not forget the numerous copper sprays being applied for canker control where needed. These other regular production practices put spray equipment in the grove throughout the year.

When developing a grove specific plan for psyllid control, begin with the grove production program already in use. Nutritional sprays, summer oil sprays and copper sprays are all times when psyllid control products may be included in the spray tank to minimize the need for additional trips through the grove. (Check the compatibility of tank mixes before application).

Next, look at where there are gaps of time and incorporate psyllid sprays where no other sprays are planned, but psyllid control is needed. One example would be the need to control overwintering adult psyllids during the winter

months when sprays traditionally have not been used. Where there are large gaps of time between anticipated ground sprays, supplemental ground sprays or aerial applications could be used to provide additional control of psyllids. When choosing which products to use for psyllid control, make sure to rotate between products with different modes of action when possible to prevent insecticide resistance. Included in Table 1 is the mode of action (MOA) for each of the pesticides recommended for use in the Florida Citrus Pest Management Guide. Rotate between products with different MOA number designations.

Over the next few years of learning to live with this new disease, everyone will become experts in managing psyllids. What does and does not work in terms of psyllid control under varying grove conditions and economic constraints will be discovered. While there is no right answer (thus far) as to how much psyllid control is needed to manage greening disease and stay in business, there is however a wrong answer. That answer is failure to do anything to control psyllid populations. Not controlling psyllids jeopardizes the future productivity of a grove while increasing the risk for neighboring groves as well.

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