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2011 Florida Citrus Pest Management Guide: Asian Citrus Psyllid and Citrus Leafminer[1]

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Asian Citrus Psyllid

Psyllid Management

The Asian citrus psyllid (*Diaphorina citri* Kuwayama) has become the most important insect pest of Florida citrus due to the presence of citrus greening disease which is spread by the psyllid. In other regions of the world where citrus is grown and greening disease is present, use of insecticides to control the psyllid vector has been a major component of greening management strategies. While no scientific data has been collected in these countries to demonstrate that insecticide use has indeed provided a benefit in terms of reducing or slowing the spread of greening disease, anecdotal evidence suggests that reducing psyllid populations via insecticide application does help to slow the rate of spread of the disease. However, it should be noted that elimination of the disease from an area has never been successful.

The products recommended in this chapter for psyllid suppression have been demonstrated in field trials conducted by the University of Florida to be effective for reducing psyllid populations. However, it should be noted that ***most of these products will have negative effects on natural enemy populations*** that keep other potential pests below damaging levels. Thus, ***it is likely that new pest problems may develop as a result of increased insecticide use for psyllid suppression***. However, the problems posed by these other potential pests are far less serious than the threat posed by citrus greening disease.

The goal of psyllid management programs is to reduce (not eliminate) psyllid populations in commercial citrus groves. Management programs should be developed specifically for a given set of growing conditions attempting where possible to reduce the number of pesticide applications used to minimize costs and negative impacts on beneficial insects and mites. The following information is

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provided to aid in the development of site-specific psyllid management programs.

Factors Affecting Psyllid Populations

The two main factors that affect the abundance of psyllids are 1) presence of new flush, and 2) temperature.

New flush is required for psyllid females to lay eggs as well as for subsequent development of the psyllid nymphs. Female psyllids lay their eggs in developing leaf buds and on feather-stage flush which has not yet unfurled. Once young leaves have begun to expand, they are no longer attractive to psyllids for egg laying. When suitable flush is not available for egg laying, psyllids may either remain on a tree feeding on the mature leaves until new flush is available for reproduction or they may leave the tree in search of other host plants on which to lay their eggs. These plants may be citrus trees within the same grove (particularly young resets which flush more often) or trees producing flush in neighboring groves. Therefore, psyllid management practices in one grove may affect future psyllid populations in nearby surrounding citrus groves.

Temperature is also closely linked to the abundance of psyllids in the field. The ideal temperature conditions for psyllids are between 68-86°F. At these temperatures, a single female psyllid can live for as many as 30-50 days and may lay as many as 300 to 750 eggs according to laboratory studies. When the daily temperatures are above 90°F, the average lifespan of a female psyllid decreases to less than 30 days in the laboratory with an average of fewer than 70 eggs produced per female at these higher temperatures. Thus, under Florida conditions, psyllid populations will be lower during the mid summer months compared to late spring and even early fall due to both high temperatures and a reduced amount of new flush available for egg laying.

Psyllid Feeding Damage and Disease Transmission

Psyllid feeding damage is limited to new growth resulting in curling and distortion of the young leaves due to injection of toxins present in saliva that is injected during the course of feeding on plant fluids. Because of the nature of this damage, in the absence of citrus greening disease, past control recommendations were targeted only to young trees on which the new flush comprised a significant portion of the total leaf canopy. Since the citrus greening pathogen is now present in Florida, it is necessary to manage psyllid populations on bearing and nonbearing trees to reduce the risk and spread of greening.

Much of the information on transmission of the citrus greening pathogen by the Asian citrus psyllid is still unclear. Previous studies on psyllid-pathogen transmission suggests that a healthy psyllid feeding on a greening-infected plant may be able to pick up the pathogen with as little as 30 minutes of feeding. After picking up the bacteria, there is a latent period which may be as short as 7 days or as long as 25 days before the psyllid can transmit the pathogen. Transmission of the pathogen is thought to occur through salivary secretions, requiring 1-7 hours of feeding for successful transmission to occur. Detailed studies are underway to examine the exact nature of transmission in the Florida environment including the investigation of whether pathogen transmission might be prevented or reduced by the use of insecticides.

Chemical Control

Nonbearing Trees

Young trees that produce multiple flushes throughout the year are at greater risk of greening infection than mature trees because of the attraction of adult psyllids to the new flush. Even without greening, young trees in the field need to be protected for about 4 years from psyllids and leafminers to grow optimally. Soil-applied systemic insecticides will provide the longest lasting control of psyllids with the least impacts on beneficials. Currently three soil-applied insecticide active ingredients (aldicarb, imidacloprid and thiamethoxam) are available that provide control of psyllids on young nonbearing trees.

Aldicarb is a systemic carbamate insecticide that can be applied to both young trees and large bearing trees. Applications of aldicarb may not be suitable, however, for newly planted trees (less than 1 year

after planting) since the root system might not have spread far enough away from the trunk of the tree to allow proper placement of the aldicarb granules by the applicator. Aldicarb applications applied to young trees (less than 8 ft in height) will require 2-3 weeks for product uptake by the root system and subsequent transport to the leaves. Aldicarb applications can only be made by a certified applicator and are limited to the period of November 15 through April 30.

Imidacloprid and thiamethoxam are both neonicotinoid insecticides which, depending on the formulation, may be applied as either soil-drench or foliar applications. However, drench applications are by far the most effective way to use these products. Soil-drenches are best applied using an applicator metered to deliver 8-10 oz of formulated drench solution to each tree. Drench applications should be applied directly at the soil-rootstock interface. Use restrictions limit imidacloprid applications to no more than 0.5 lbs AI/A per growing season, regardless of application method. This equates to 14 fluid ounces per acre for 4.6F formulations or 32 fluid ounces per acre for 2F formulations. Use restriction limits also exist for thiamethoxam which allow no more than 0.172 lb AI/A (or 3.67 oz Platinum) per growing season regardless of which thiamethoxam product is used. Due to the restrictions on the amount of these products that can be used in a growing season, drenches in solid blocks are only feasible in young trees up to about 6 feet in height with the number of applications possible per year dependent on tree size. Soil applications of imidacloprid and thiamethoxam can be applied to resets within blocks of mature trees at greater frequency or higher rates as long as the limits on amount of AI/A applied is not exceeded. Imidacloprid and thiamethoxam share the same mode of action and thus the two products are not considered alternatives for rotation to prevent pesticide resistance. Foliar sprays of products other than imidacloprid or thiamethoxam should be used between soil-drench applications to provide additional control of psyllid populations and to help minimize the potential for insecticide resistance development.

Bearing Trees

Management options for psyllid control on bearing trees are much more limited than for nonbearing trees. Currently, the only soil-applied insecticide that has been shown to provide any reduction in psyllid numbers on large trees is aldicarb. If aldicarb is applied to bearing trees as a part of a program for psyllid management, application should be made at least 30 days prior to the initiation of flushing. This timing will allow for the material to move from the roots up to the tree canopy.

At present, the only other chemical control option that has been demonstrated to be effective for reducing psyllid populations on bearing trees is the use of broad-spectrum foliar insecticide applications. Broad-spectrum foliar sprays are most effective when used to control adult psyllids prior to the presence of new flush. Once psyllids begin reproducing on new flush, it becomes increasingly difficult to gain control of rapidly increasing populations. Psyllid management programs should begin by first targeting overwintering adult psyllids during the winter months when the trees are not producing flush. By eliminating these overwintering adults, psyllid populations will be greatly reduced on the following spring flushes. By targeting psyllids early in the year, this should provide enough suppression in psyllid populations to reduce the need for psyllid sprays during bloom when pollinators are present and most pesticide products cannot be applied. Additional sprays for psyllids should be made when observing an increase in adult populations in a grove.

Biological Control

Foliar insecticide applications should only be used when needed to minimize the impact on natural enemies that maintain psyllids at lower levels later in the year. While a single female psyllid can lay as many as 800 eggs, studies in Florida and Puerto Rico have shown that over 90% of psyllids that hatch in the field do not survive to become adults. Many are consumed by predaceous insects such as ladybeetles. The parasitic wasp, *Tamarixia radiata*, has become established throughout Florida and also contributes some mortality especially in fall. Additionally, there are many potential pests such as scales, mealybugs, whiteflies, etc. that are currently maintained at low

levels in Florida citrus due to biological control. Excessive sprays could result in resurgence of these pests.

Other Management Considerations

In groves where citrus greening has been confirmed, trees showing signs of infection should be removed quickly. Foliar insecticides that provide quick knockdown of psyllids should be sprayed on the infected tree(s) prior to removal to prevent further spread of the pathogen by psyllids. Otherwise, the greening-infected psyllids will disperse from the tree(s) being removed and infest nearby healthy trees. Be sure to follow re-entry interval (REI) directions on the pesticide label. Trees in the immediate vicinity of infected trees should be considered higher risk due to increased likelihood of infection and receive extra scouting and treatment if necessary.

Management practices used within a grove can also affect psyllid populations, especially those practices that promote new flush such as hedging and topping and fertilization. Trees should always be sprayed with a broad spectrum insecticide prior to or just after hedging and topping before any flush develops. Management strategies that reduce or limit the duration of flush may help to keep psyllid populations at low levels and reduce the need for additional pesticide applications. Alternate host plants surrounding citrus can serve as a source of psyllids for infestation. Two common host plants, orange jasmine (*Murraya paniculata*) and box orange (*Severinia buxifolia*), are host plants for both the psyllid and the greening pathogen. When possible, both of these plant species should be removed from areas surrounding commercial citrus groves.

Bee Caution

Citrus growers should be aware that most of the broad-spectrum insecticides recommended for psyllid control cannot be applied when citrus is blooming due to the impact these products may have on pollinators. Planning ahead to control psyllids prior to the presence of bloom will help reduce the need to apply pesticides during the bloom period. Check the pesticide label for restrictions on application of a product when trees are in bloom.

Citrus Leafminer

Adults of the citrus leafminer (*Phyllocnistis citrella*) are tiny moths that hide within the canopy during the day and emerge at night to lay eggs individually on young, expanding leaf flushes. The egg first appears as a tiny dew drop, usually alongside the midvein on the underside of an unexpanded leaf. The larva emerges directly into the leaf tissue, mining first along the midvein, then back and forth as it makes its way to the leaf margin where pupation occurs.

Leafminer populations decline to their lowest levels during the winter due to cool temperatures and the lack of flush for larval development. Populations of leafminer build rapidly on the spring flush, although their presence is not apparent until late spring as populations increase while the amount of new foliage decreases. Throughout the ensuing warm season, leafminer populations vary with the flushing cycles and subsequent flushes are often severely damaged. The summer period of high leafminer damage coincides with the rainy season when canker spread is most likely.

Citrus leafminer greatly exacerbates the severity of citrus canker caused by *Xanthomonas axonopodis* pv. *citri*. This insect is not a vector of the disease. Nevertheless, leafminer tunnels are susceptible to infection much longer than mechanical wounds. Tunnels infected by canker produce many times the amount of inoculum than in the absence of leafminer. Control of leafminer should be optimized in areas where infection by canker is high. Natural enemies already present in Florida have responded to leafminer infestations, causing up to 90% mortality of larvae and pupae. These natural enemies include the introduced parasitoid *Ageniaspis citricola* that has established throughout most of Florida and is responsible for up to 30% of this mortality mostly later in the year.

Leafminer Management

Nonbearing Trees

On young trees, use of the soil-applied systemic insecticide imidacloprid is the most effective means of preventing mining damage on the new flush and has little direct effect on natural enemies. Soil drenches directly to the base of the tree with imidacloprid have been shown to provide at least 8 weeks control of leafminer. Injection through the irrigation system is less effective because a large portion of the material falls beyond the root zone. Compared to soil-applications of imidacloprid, foliar-applied insecticides provide a shorter duration of protection lasting only about 2 weeks depending on weather conditions and the uniformity of flush pattern.

Soil applications of imidacloprid should be made about 2 weeks prior to leaf expansion to allow time for the pesticide to move from the roots to the canopy. Avoid applications 24 hours prior to significant rainfall events which will result in movement of the product out of the root zone before it can be taken up by the plant. Because of limits on the amount of imidacloprid that may be applied on a per acre basis each season, only one application in the spring and possibly one in the fall are recommended. When the residual effects of the spring application have worn off, typically during the mid-summer rainy season, foliar sprays of other materials can be used on small trees to reduce leafminer damage if necessary. Reapplication of imidacloprid is not recommended during this part of the season because of the likelihood of the material being washed away by frequent summer rains. Foliar sprays should be timed to coincide with the appearance of the first visible leaf mines which occur immediately following the feather leaf stage or about 13 days after budbreak. At this time, insecticide applications will provide protection for most of the leaves in the new flush.

Bearing Trees

If canker is present in a grove (or in a nearby grove), healthy trees with leafminer-damaged leaves are more likely to become sites for new canker infection. The only products currently available for leafminer control on large trees are foliar insecticide sprays. Soil applications of imidacloprid are not effective for leafminer control on large trees due to use rate restrictions that limit the effectiveness of the product on trees greater than 6-8 feet in height. It should also be noted that aldicarb (Temik®), which has been demonstrated to suppress psyllid populations on large trees, does not provide control of leafminers. While a number of products are effective against this pest, achieving control of leafminer using foliar sprays on large trees is difficult due to the unsynchronized flush typically encountered during summer and fall. However, since leafminers affect only developing leaves, coverage of peripheral leaves in the canopy should be adequate to exert suppression when applying foliar pesticides.

Recommended Chemical Controls

READ THE LABEL.

Some product labels specify rates per acre, while others specify rates per volume delivered (e.g. per 100 gallons). Refer to label for details on how product should be mixed for desired targets.

Rates for pesticides are given as the maximum amount required to treat mature citrus trees unless otherwise noted. When treating smaller trees with commercial application equipment including handguns, mix the per acre rate for mature trees in 100 gallons of water. Calibrate and arrange nozzles to deliver thorough distribution and treat as many acres as this volume of spray allows.

Table 1. Recommended Chemical Controls for the Asian Citrus Psyllid

Pesticide/ Trade name[1,4]	IRAC MOA[2]	Rate/Acre	Evaluated for Asian Citrus Psyllid[3]	Comments	Other Pests Controlled
Aldicarb				Restricted use pesticide. Notification of intent is required. Application permitted only between Nov. 15 and Apr. 30. See label for application restrictions. When psyllid control is required on mature trees, apply at least 30 days prior to anticipated flush.	Aphids, citrus rust mites, citrus nematodes
Temik 15G	1A	33 lbs	+		
Chlorpyrifos				Restricted Use Pesticide. Highly toxic to bees. May increase spider mite populations. Lorsban 4E has a 2(ee) label for control of Asian citrus psyllid; other formulations of chlorpyrifos are not currently labeled for psyllid control.	Mealybug, orangedog, katydids, grasshoppers, aphids, thrips
Lorsban 4E	1B	5 pts	+		
Dimethoate				Highly toxic to bees, do not apply during bloom. Do not make more than 2 applications per crop season. Consult label for buffering instructions when water pH is greater than 7.	Aphids, scales except snow scale and black scale, flower thrips
Dimethoate 4 E	1B	1 pt	+		
Fenpropathrin				Restricted use pesticide. Highly toxic to bees. May result in increased rust mite populations. May have significant negative effects on beneficial insect populations.	Flower and orchid thrips, adult root weevils
Danitol 2.4EC	3	1 pt	+		
Imidacloprid (foliar application)	4	10 to 20 fl oz		Limit of 0.5 lbs / AI per acre per growing season regardless of application type (soil and/or foliar) and trade name of imidacloprid product used. Do not apply during bloom or within 10 days of bloom or when bees are actively foraging.	Aphids
Couraze 1.6F			ID (+)		
Nuprid 1.6F			ID (+)		
Pasada 1.6F			ID (+)		
Provado 1.6F			+		
Imidacloprid (soil-drench)	4			Limit of 0.5 lbs / AI per acre per growing season regardless of application type (soil and/or foliar) and trade name of imidacloprid product used. Recommended application is a soil drench made to base of trees up to 6 feet tall.	Aphids, citrus leafminer
Admire Pro 4.6F	4	7 to 14 fl oz	+		
Admire 2F	4	16 to 32 fl oz	+		
Alias 2F			ID (+)		
Couraze 2F			ID (+)		
Nuprid 2F			ID (+)		

Table 1. Recommended Chemical Controls for the Asian Citrus Psyllid

Pesticide/ Trade name[1,4]	IRAC MOA[2]	Rate/Acre	Evaluated for Asian Citrus Psyllid[3]	Comments	Other Pests Controlled
Phosmet				Highly toxic to bees, do not apply during bloom. Consult label for buffering instructions when water pH is greater than 7. Do not make more than 2 applications per season. EPA SLN No. 10163-169, FIFRA 2(ee).	Citrus root weevils
Imidan 70 W	1B	1.0 lb	+		
Spinetoram				Highly toxic to bees, do not apply during bloom. Do not apply more than 12 oz of product (0.188 lb ai) per acre per season. Do not make more than 3 applications per calendar year.	Citrus leafminer
Delegate WG + Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	5	4 oz + 2% v/v	+		
Spirotetramat				Limit of 20 oz of product (0.32 lb ai) per acre per season. Do not apply within 10 days prior to bloom, during bloom, or until petal fall is complete.	Citrus rust mites, some scale insects
Movento 240 SC + Petroleum Oil 97+% (FC 435-66, FC 455-88 or 470 oil)	23	10 oz + 3% v/v	+		
Thiamethoxam (foliar application)	4				
Actara 25 WG	4	4.0-5.5 oz	+	Do not exceed a total of 11.0 oz/Acre (0.172 lb a.i./A) of Actara or 0.172 lb a.i. of thiamethoxam-containing products per acre per growing season. Do not apply during pre-bloom or during bloom when bees are actively foraging.	Aphids
(soil drench)					
Platinum 75 SG	4	1.83-3.67 oz	+	Do not exceed a total of 3.67 oz/Acre (0.172 lb a.i./A) of Platinum 75 SG or 0.172 lb a.i. of thiamethoxam-containing products per acre per growing season. Do not apply during pre-bloom or during bloom when bees are actively foraging.	Aphids, citrus leafminer
Zeta-cypermethrin				Restricted use pesticide. Highly toxic to bees, do not apply during bloom. Do not make more than 4 applications (0.20 lb ai) per acre per season.	Citrus root weevils
Mustang Insecticide	3	4.3 oz	+		

Table 1. Recommended Chemical Controls for the Asian Citrus Psyllid

Pesticide/ Trade name[1,4]	IRAC MOA[2]	Rate/Acre	Evaluated for Asian Citrus Psyllid[3]	Comments	Other Pests Controlled

[1] Trade names provided are all products for a given active ingredient that have been tested and are currently labeled for psyllid control.
[2] Mode of action class for citrus pesticides from the Insecticide Resistance Action Committee (IRAC) Mode of Action Classification V7 (2010). Refer to ENY-624, Pesticide Resistance and Resistance Management, in the 2011 Florida Citrus Pest Management Guide for more details.
[3] + = products have been tested in multiple trials and have provided adequate control of the Asian citrus psyllid; ID(+) = incomplete data with only one trial conducted to date demonstrating efficacy.
[4] Additional trade names of products with the same active ingredient that have not been tested to determine efficacy are listed in chapter ENY-601 Pesticides Registered for Use on Florida Citrus.

Table 2. Recommended Chemical Controls for Citrus Leafminer.

Pesticide/Trade Name	IRAC MOA[1]	Rate/Acre[2]	Comments	Other Pests Controlled
Abamectin				
Agri-Mek 0.15 EC + Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	6	5 oz + min of 1 gal oil	Do not apply Agri-Mek or any other abamectin-containing product within 30 days of last treatment. Do not apply more than 40 fl oz of Agri-Mek or any abamectin-containing product in a growing season. Do not make more than 3 applications of Agri-Mek or any abamectin-containing product in a growing season. Always apply with spray oil as directed. Do not apply in citrus nurseries.	Aphids, citrus psyllids
Acetamiprid				
Assail 70 WP	4	2 oz	Do not apply within 7 days of harvest.	
Diflubenzuron				
Micromite 80WGS + Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	15	6.25 oz + 2% v/v	Do not apply more than 3 applications per season. See restrictions on label. Do not apply when temperatures exceed 94°F.	Citrus root weevils, citrus rust mites
Imidacloprid (soil drench)				

Table 2. Recommended Chemical Controls for Citrus Leafminer.

Pesticide/Trade Name	IRAC MOA[1]	Rate/Acre[2]	Comments	Other Pests Controlled
Admire Pro	4	7-14 oz	Limit of 0.5 lb/AI per acre per growing season regardless of application type (soil and/or foliar) and trade name of imidacloprid product used. Recommended application is a soil drench made to base of trees up to 6 feet tall. Apply prior to or at onset of pest infestation for optimal results.	Citrus psyllids
Admire 2 F	4	16-32 oz		
Methoxyfenozide				
Intrepid 2F + Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	18	8 oz + 2% v/v	Do not apply more than 16 fl oz per acre per application or 64 fl oz of product per acre per season. Do not apply within 14 days of last application.	
Petroleum Oil				
97+% (FC 435-66, FC 455-88, or 470 oil)	NR[3]	5 gal	Do not apply when temperatures exceed 94°F. 470 weight oil has not been evaluated for effects on fruit coloring or ripening. These oils are more likely to be phytotoxic than lighter oils.	
Spinetoram				
Delegate WG + Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	5	6 oz + 2% v/v	Do not apply more than 12 oz of Delegate WG in a growing season. Do not make more than 3 applications in a growing season. Do not apply within 7 days of last treatment.	Citrus psyllids, orangedog
Spinosad				
SpinTor 2SC	5	6 oz	Limit of 2 applications per season.	Orangedog
Thiamethoxam (soil drench)				
Platinum 75 SG	4	1.83-3.67 oz	Do not exceed a total of 3.67 oz/Acre (0.172 lb a.i./A) of Platinum 75 SG or 0.172 lb a.i. of thiamethoxam-containing products per acre per growing season. Do not apply during pre-bloom or during bloom when bees are actively foraging.	Aphids, Asian citrus psyllid

[1]Mode of action class for citrus pesticides from the Insecticide Resistance Action Committee (IRAC) Mode of Action Classification V7 (2010). Refer to ENY-624, Pesticide Resistance and Resistance Management, in the 2011 Florida Citrus Pest Management Guide for more details.
[2]Lower rates may be used on smaller trees. Do not use less than the minimum label rate.
[3]No resistance potential exists for these products.