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2006 Florida Citrus Pest Management Guide: Soft-Bodied Insects Attacking Foliage and Fruit[1]

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This section of the Citrus Pest Management Guide provides information on the group of insects belonging to the order Homoptera which affect foliage, twigs, and fruit of citrus in Florida. The insects include scale insects, mealybugs, whiteflies, psyllids, and aphids. In addition, this section includes the citrus leafminer, a moth species (Order Lepidoptera) whose larval stages tunnel through leaves and stems. These insect species affect tree health and fruit quality, and can impact mature fruiting trees as well as newly planted groves and resets. Their biologies, generation times, plant parts affected, and injury vary, but similar approaches to their monitoring and management cause them to be grouped here.

Individual discussions of some families and species are provided, and the tables of management options are organized accordingly.

Scale Insects

The most important armored scale pests in Florida are snow scale (*Unaspis citri*), Florida red scale (*Chrysomphalus aonidium*), purple scale (*Cornuaspis beckii*), Glover's scale (*Lepidosaphes gloveri*), and chaff scale (*Parlatoria pergandii*). Important soft scale insects include Caribbean black scale (*Saisseta neglecta*), brown soft scale (*Coccus hesperidium*), and Florida wax scale (*Ceroplastes floridensis*). Pest management of both armored and soft scale insects in Florida citrus is based on highly successful action of native and introduced exotic natural enemies, including predators, parasites, and pathogens. These relatively specific natural enemies co-exist with their hosts in the citrus grove under most conditions and can respond to suppress pest numbers when they periodically increase in individual groves. Thus, scale insects should not be considered key pests in development of seasonal pesticidal programs. However, there are conditions

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under which natural enemies may not function well. It is in these cases that scale insects achieve importance in our overall IPM program. Factors that are most often responsible for increases in scale populations are: a) weather conditions that disrupt biological control; b) movement of the pest to groves where natural enemies do not occur; and c) disruption of natural enemies by other practices, particularly the repeated use of non-selective insecticides during a period when natural enemies are active and exposed.

When these disruptions occur, scale populations can increase to the point where leaf, fruit, twig, branch and/or trunk populations cause damage. The sessile nature of scale insects promotes high concentrations of scales in limited areas within the grove, thus building populations can go unnoticed for several generations. Generation times for most scale species require more than one month to progress from egg to adult. Thus, populations do not build quickly like some other pest groups such as mites or aphids.

In approaching management of scale insects, the first consideration should be to determine if the problem is induced by management practices and, if so, to determine if it can be solved by changing those practices. In particular, if repeated applications of non-selective pesticides are responsible for scale population increase, then the solution is to desist and allow natural enemies to recover. If, on the other hand, seasonal fluctuations have brought about population levels of concern, then some intervention with insecticides may be required. The basis for this decision should be population levels of **live** scales that are deemed sufficient to cause damage directly or through the production of honeydew and sooty mold (soft scales only). Scale bodies from previous generations often remain on the plant for several months and may be mistaken for live scales, resulting in the application of scale pesticides at inappropriate times. For effective suppression, most scale species should be in young nymphal stages, since pesticides are not very effective against eggs, large nymphs, or adults. No economic injury levels or thresholds are available for scale insect pests. Thus, the manager must evaluate each situation, taking into account the intensity and extent of scale populations and how much damage is likely to result. Generally, the intent of spraying for scale insects is to reduce populations with a single application in a way that no additional sprays are necessary during that season and in a way that is least disruptive to the system.

Treatment, when warranted, should focus on selection of an appropriate material (see Table 1), but equally important, should be applied with thorough coverage in mind. Since scale insects are immobile, direct contact is essential. Spray volume, ground speed, nozzling, and location of the pest populations should all be emphasized to get maximum target coverage. If only a few trees are involved, then spot treatment with a handgun or other focused application equipment will provide the best results. Generally, spray applications designed for contact with pests on the outer canopy are not effective at suppressing scales, especially if the scales are numerous in the interior of the tree. The follow-up to pesticidal applications for scale insects should involve evaluation of **live** scale on the appropriate parts of the tree. Dead scale will not be visibly different from live scale at first. Hatching crawlers will also create the impression that the spray was not effective. Complete elimination of scale insects following a pesticidal spray is neither practical nor necessary, and in fact may be counterproductive.

Brown soft scale generally is not a pest needing treatment. Following mild winters and when populations build within specific groves, treatment, where needed, should be based on scouting for crawlers and young nymphs (still tan in color) during the generation that develops in April-May. Applications at other times are ineffective.

Citrus snow scale likewise is a local problem requiring occasional treatment in specific groves or portions of groves. Evidence for the need to treat includes high populations of crawlers showing on patches of bark that have been brushed clean during the previous week, and the association of visible snow scale populations with bark splitting, particularly on young trees that are rapidly increasing in trunk girth. Spot treat wood of heavily infested trees to runoff with a handgun application.

Mealybugs

Citrus mealybugs (*Planococous citri*) are normally under good biological control by a complex of natural enemies in citrus. Their waxy covering, sedentary lifestyle, and preference for feeding in concealed locations make them very difficult to kill with insecticides. Only the most toxic materials have appreciable efficacy against mealybugs, materials that also pose risks to the environment and are most likely to disrupt biological control of other pests. Consequently, treatment is warranted only in cases of severe infestations, or when the fruit itself is attacked. Systemic materials give superior control while minimizing impacts on beneficials, but may not act quickly enough to prevent damage when high populations are established.

Whiteflies

The most important whiteflies in Florida are citrus whitefly (*Dialeurodes citri*), the cloudy-winged whitefly (*D. citrifollii*), the wooly whitefly (*Aleurothrixus floccosus*), and citrus blackfly (*A. woglumi*). Whiteflies are dependent on new growth for their development and reproduction; consequently, they are active in citrus only during periods of flush. Large populations of these insects can deposit considerable volumes of honeydew, leading to sooty mold accumulation. These insects are constantly present in most groves in very low numbers and are normally under good biological control by various specialist parasitoids and generalist predators. Populations are rarely heavy enough to warrant treatment unless biological control has been disrupted. Serious infestations of whiteflies are an indication that management practices should be reviewed.

Psyllids

The Asian citrus psyllid (*Diaphorina citri* Kuwayama) requires young tender flush for reproduction and development. Adult females lay eggs on the new flush as it begins to expand. Upon emerging from the egg, the psyllid nymphs begin feeding on the expanding flush. The optimum temperature for rapid psyllid population growth is 70-85°F. Within this temperature range, adult females can lay as many as 800 eggs with a development time from egg to adult in about 2 weeks. While psyllids are similar to aphids in requiring new flush for development, adult psyllids can survive on hardened leaves until new flush is available. When no new flush is available, adult psyllids can be found feeding on the midvein on the underside of leaves.

Psyllid feeding damage is limited to new growth resulting in curling of the young leaves due to the withdrawal of plant fluids. Because of the nature of this damage, past control recommendations were targeted to young trees on which the new flush comprised a significant portion of the total leaf canopy.

More important than the direct damage caused by psyllid feeding is the role of the psyllid as a vector of the phloem-limited bacterium that causes huanglongbing or citrus greening disease. In August 2005, citrus greening was found in south Florida and has since been confirmed in commercial citrus groves in the south part of the state. While it is unlikely that pesticide applications and other management strategies targeting psyllids will provide complete control of greening, efforts to manage psyllid populations (together with removal of trees that are visibly infected with greening) will be necessary to slow the spread of the disease in groves where present.

Foliar insecticides for psyllid control on mature citrus trees should be applied during the major flushing periods, especially the spring and summer leaf flushes when psyllids are most abundant. Applications should be timed to coincide with the initial expansion of the new flush. Since multiple insecticide applications will be made within a growing season, rotate between insecticides with different modes of action to prevent the development of pesticide resistance.

For young citrus trees, use of systemic pesticides, such as imidacloprid (Admire), are effective for suppressing psyllid populations over an extended period of time. Since use of imidacloprid is limited to 32 fl oz per acre each season, usually only one or two applications can be applied each growing season. Foliar sprays can be used to supplement soil-applied products for psyllid control. Another

systemic pesticide, aldicarb (Temik), has been shown to be effective in reducing psyllid populations in field trials when applied at a rate of 33 lbs per acre to trees less than 6 feet in height. Studies evaluating the effectiveness of Temik for psyllid control in other countries have shown that Temik may help to suppress psyllid populations but can take up to 30 days for the product to move throughout large trees and begin affecting psyllids feeding on new flush. An evaluation of the effectiveness of Temik for controlling psyllids on mature citrus trees is ongoing. Recommendations regarding Temik and other pesticides for psyllid control will be updated in the online version of the Florida Citrus Pest Management Guide as soon as more information is available. See Table 1 for current product recommendations for control of Asian citrus psyllid.

Aphids

The most common aphids in Florida citrus are the green citrus aphid (*Aphis spiraecola*), the cotton or melon aphid (*A. gossypii*), and the brown citrus aphid (*Toxoptera citricida*). Brown citrus aphid is particularly important as a vector of citrus tristeza virus. Aphids are dependent on the availability of newly expanding leaves for their development and reproduction, so these insects may be problems during periods of new citrus growth, primarily spring and fall. Aphids are largely controlled by many generalist natural enemies such as ladybeetles, hoverflies, and lacewings, that normally maintain their populations, and those of other flush-feeding insects, below levels that warrant treatment in producing groves. Excessive honeydew accumulation on leaves will result in the growth of sooty mold fungus that blocks light and reduces photosynthetic activity. However, mature groves sustain little damage and should not need treatment. Treatment is warranted only in young groves (< 3 yrs old) if a large portion (i.e. > 50%) of expanding terminals is infested. Surveys for aphids should be conducted early in flushing cycles when most terminals are still in the feather stage. Systemic materials, such as Temik or Admire, applied to the soil will give good control with minimal impact on beneficial species, but the time required for uptake of these materials by the tree restricts their usefulness as preventive, rather than responsive, treatments.

Citrus Leafminer

Citrus leafminer (*Phyllocnistis citrella*) (CLM) can occur on new flush throughout the growing season but typically affects little of the important spring flush. Since subsequent flushes do not account for significant portions of the total leaf crop on mature trees, CLM damage generally does not significantly affect growth and yield except on young trees. Under southwest Florida conditions, the cutoff point has been shown to be about 4 years of age. Less damage could be expected in more northerly locations. Nursery stock and young resets are most affected by CLM injury. Leafminer populations build on flush growth. Thus, grove practices that will deter winter flushes should be encouraged. A strong synchronized spring flush should offset the loss of small sporadic winter flushes. Climatic conditions will ultimately determine flushes; however, irrigation and fertilization during the winter should be restricted to maintain tree health. Mechanical hedging should be delayed if possible until cooler winter temperatures prevail, thus limiting regrowth. Irrigation and fertilization should be initiated in early to mid January, slightly in advance of the anticipated spring flush.

CLM greatly exacerbates the severity of citrus canker caused by *Xanthomonas axonopodis* pv. *citri*. This insect is not a vector of the disease. Nevertheless, CLM 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 CLM. Control of CLM should be optimized in areas where infection by canker is high.

Natural enemies already present in Florida have responded to CLM infestations, causing in excess of 50% mortality of larvae and pupae in some areas. The introduced parasitoid *Ageneaspis citricola* has established throughout most of Florida, with rates of apparent parasitism reaching 90% or more. Thus, biological control makes a significant contribution, even where chemical control may be required. Therefore, natural enemies should be conserved by avoiding unwarranted pesticide use, especially broad spectrum insecticides.

The CLM developmental period from egg to adult is as short as 14 days. Within this cycle, the susceptible larval stage may occupy only 4-5 days. Thus, pesticidal applications for control of CLM will only affect a small proportion (larvae) of the population. Furthermore, residual activity of pesticides is limited by rapid appearance of new and unprotected flush, so that 14-21 days' control is the best that can be expected, even under ideal conditions. Scouting is therefore necessary to determine peak periods of larval activity during flushing periods when chemical suppression might be justified. A scouting program should be initiated to monitor CLM development when 50% of the trees are producing flush. Pesticidal control should be considered only when the new flush is anticipated to constitute about 20% of the entire leaf area. Under these conditions, application should begin when about 30% of the flush leaves show active mines to maximize the susceptibility of larvae and thus have the greatest impact on CLM populations. Pesticides should be rotated to reduce selection for resistance. Since CLM affects only developing leaves, coverage of peripheral leaves in the canopy should be adequate to exert suppression when applying pesticides for CLM. The products listed in Table 1 for CLM management have been the most consistently effective. To be consistent with other tables, per acre rates are based on fully mature trees. Therefore, the rate shown in 250 gallons of water should treat several acres of small trees.

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.

See Table 1.

Rates for pesticides are given as the maximum amount required to treat mature citrus trees unless otherwise noted. To treat smaller trees with commercial application equipment including handguns, mix the per acre rate for mature trees in 250 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 Scale Insects[1], Mealybugs, Whiteflies, Psyllids, and Aphids

Pesticide	IRAC MOA[3]	Mature Trees Rate/Acre[2]	Comments	Other Pests Controlled
		Scale Insects		
Dimethoate 2.67 EC Dimethoate 4 EC Dimethoate 5 EC	1B	See label	Does not control citrus snow scale or black scale.	Aphids
Guthion 2 L Guthion 50 WP Azinphos-Methyl	1B	6 pt 4 lb 6 pt	Do not use spray solutions above pH 8. Do not use 2 L formulation with oil. May increase citrus red mite and Texas citrus mite.	Whiteflies, mealybugs, adult citrus root weevils
Chlorpyrifos 4 EC Chlorpyrifos 50 W	1B	5 pt 5 lb	May increase spider mite populations.	Mealybugs, orangedog, katydids, grasshoppers, aphids, thrips
Malathion 5 EC Malathion 8 EC	1B	6 pt	Glover and yellow scale. Does not control chaff or black scale.	Plant bugs, crickets
Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	NR[4]	10 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.	Citrus rust mites, whiteflies, greasy spot, sooty mold
Carbaryl 80 S Carbaryl 4 F Sevin XLR	1A	3.1 lb 2.5 qt 2.5 qt	May increase citrus red mite and Texas citrus mite populations. Do not exceed 20 lb a.i./acre/year for all uses.	Adult root weevils, orangedog, crickets, katydids, grasshoppers
		Mealybugs		
Guthion 2 L Guthion 50 WP Azinphos-Methyl	1B	6 pt 4 lb 6 pt	Apply before fruit becomes infested. Application after the fruit has set will kill exposed mealybugs but not those that have settled under the button. Do not use in spray solutions above pH 8. Do not use 2 L formulation with oil.	Scale insects, whiteflies
Chlorpyrifos 4 EC Chlorpyrifos 50 W	1B	5 pt 5 lb	May increase spider mite populations.	Aphids, crickets, flower and orchid thrips, grasshoppers, katydids, orangedog, scale insects
		Whiteflies		
Guthion 2 L Guthion 50 WP Azinphos-Methyl	1B	6 pt 4 lb 6 pt	Apply postbloom after the adult females have deposited their eggs, followed by a summer application. Do not use spray solutions above pH 8. Do not use 2 L formulation with oil. May increase citrus red mite and/or Texas citrus mite populations.	Scale insects

Table 1. Recommended Chemical Controls for Scale Insects[1], Mealybugs, Whiteflies, Psyllids, and Aphids

Pesticide	IRAC MOA[3]	Mature Trees Rate/Acre[2]	Comments	Other Pests Controlled
Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	NR[4]	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.	Spider mites, scale insects other than citrus snow scale, sooty mold
Temik 15 G	1A	33 lb	See Method of Application statement under Nematodes, Table 1.	Citrus nematodes, citrus rust mites, aphids, psyllids
Asian Citrus Psylla				
Admire 2F	4	16 to 32 fl oz per grove acre **OR** 1/8 oz per tree (4-6' height)	Soil applied systemic intended primarily for use on young trees. Apply prior to or at onset of pest infestation for optimal results. See label for application options. Do not apply more than 32 oz/A/yr.	Aphids, citrus leafminer
Provado 1.6F	4	10 to 20 fl oz per acre	Foliar-applied systemic	Aphids
Danitol 2.4EC	3	1 pt	Highly toxic to bees	Flower and orchid thrips, adult root weevils
Lorsban 4EC	1B	5 pt	May increase spider mite populations.	Mealybug, orangedog, katydids, grasshoppers, aphids, thrips
Temik 15 G	1A	33 lb	See Method of Application statement under Nematodes, Table 1. Temik application for psyllid control on bearing trees should be made 30 days prior to anticipation of new flush.	Citrus nematodes, citrus rust mites, aphids, psyllids
Aphids				
Admire 2 F	4	See label	Soil applied systemic intended primarily for use on young trees. Apply prior to or at onset of pest infestation for optimal results. See label for application options. Do not apply more than 32 oz/A/yr.	Citrus leafminer, citrus root weevils, citrus psyllid
Dimethoate	1B	See label		Flower thrips, scale insects except citrus snow and black scale
Chlorpyrifos 4 EC Chlorpyrifos 50 W	1B	5 pt 5 lb	May increase spider mite populations.	Crickets, flower and orchid thrips, grasshoppers, katydids, mealybugs, orangedog, scale insects
Provado 1.6 F	4	10 to 20 fl oz per acre	Foliar applied systemic	Citrus psyllid
Temik	1A	33 lb	See Method of Application statement under Nematodes, Table 1.	Citrus rust mites, whiteflies, citrus nematode

Table 1. Recommended Chemical Controls for Scale Insects[1], Mealybugs, Whiteflies, Psyllids, and Aphids

Pesticide	IRAC MOA[3]	Mature Trees Rate/Acre[2]	Comments	Other Pests Controlled
[1]Pesticides will control all major scale pests unless otherwise noted under comments. [2] Lower rates may be used on smaller trees. Do not use less than minimum label rate. [3]Mode of action class for citrus pesticides from the Insecticide Resistance Action Committee (IRAC) Mode of Action Classification V4.2.1 (2005). Refer to ENY624, Pesticide Resistance and Resistance Management, in the 2006 Florida Citrus Pest Management Guide for more details. [4]No resistance potential exists for these products.				

Table 2. Recommended Chemical Controls for Citrus Leafminer (Nonbearing/Young Bearing Citrus)

Pesticide	IRAC MOA[2]	Mature Trees Rate/Acre[1]	Comments	Other Pests Controlled
Admire 2 F	4	16 to 30 fl oz per grove acre **OR** 1/8 oz per tree (4-6' height)	Soil applied systemic intended primarily for use on young trees. Apply prior to or at onset of pest infestation for optimal results. See label for application options. Do not apply more than 32 oz/A/yr.	Aphids, citrus psyllid
Agri-Mek 0.15 EC + Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	6	5 oz + min of 1 gal	Do not apply within 7 days of harvest. Do not apply within 30 days of last treatment. Do not make more than 3 applications or apply more than 40 fl oz/growing season. No more than 1 application per year recommended to avoid pest resistance. Always apply with horticultural spray oils as directed. Do not apply in citrus nurseries. Do not apply by aircraft. 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.	Citrus rust mites, citrus bud mite, broad mite (See ENY 603 for appropriate rates)
Assail 70 WP	4	2 oz	Do not apply within 7 days of harvest.	
Micromite 80WGS + Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	15	6.25 oz	Up to three applications per season. See restrictions on the label. 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.	Citrus root weevils, citrus rust mites
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.	
Spintor 2SC	5	6 oz	Limit of 2 applications per season.	Orangedog
[1]Lower rates may be used on smaller trees. Do not use less than the minimum label rate. [2]Mode of action class for citrus pesticides from the Insecticide Resistance Action Committee (IRAC) Mode of Action Classification V4.2.1 (2005). Refer to ENY624, Pesticide Resistance and Resistance Management, in the 2006 Florida Citrus Pest Management Guide for more details. [3]No resistance potential exists for these products.				