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2023–2024 Florida Citrus Production Guide: Citrus Root Weevils[1]

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Citrus root weevils represent a complex of species known to infest citrus trees and various alternate host plants in Florida. The most common species infesting citrus, in order of greatest geographical distribution, are the Diaprepes root weevil, *Diaprepes abbreviatus*; the blue-green citrus root weevils, *Pachnaeus litus* and *Pachnaeus opalus*; the little leaf notcher, *Artipus floridanus*; and the Fuller rose beetle, *Asynonychus godmani*. Other lesser species inhabit citrus on occasion.

All citrus root weevils have a similar life cycle. They have three immature stages: egg, larva, and pupa. Adult weevils emerge from the soil and lay eggs on host plants aboveground, the larvae drop to the soil to feed on roots, and the pupae and teneral adult stages are spent belowground. Adults emerge from the soil throughout the year. Peak emergence varies within species and by geographical region (ridge vs. coastal and interior flatwoods). Peak adult emergence for the blue-green root weevils and Fuller rose beetle is normally April and May. *Diaprepes* adult emergence from the soil peaks in late May to early July, while peak adult abundance on the tree canopy parallels adult emergence in May/June but can have a second peak in late August to mid-October. The second peak is sporadic. The little leaf notcher has three generations per year. Although there is some overlap of generations, adults appear most abundant on trees in April/May, July/August, and October/November. All adult weevils are attracted to the nonreflective silhouette of the citrus tree trunk. The little leaf notcher and Fuller rose beetle are flightless and must crawl up the trunk, but other species will fly to the canopy.

The most visible plant damage resulting from adult feeding is notching of the margins of leaves of young, tender shoots. Notching patterns differ slightly among species and can be confused with grasshopper injury. Prolonged leaf feeding by adults appears to cause no economic effects in mature groves; however, on occasion, feeding will cause virtual defoliation of small replants.

With the exception of little leaf notchers, which prefer a weed host, larval feeding injury to the roots by other root weevils, particularly Diaprepes root weevil, can have a devastating effect on citrus trees because all larval stages feed on the roots for most of the year. Tiny hatchlings feed on fibrous roots, whereas larger larvae feed on the larger

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structural roots, forming deep grooves as they consume the outer bark, including the cambium layer. Roots may be girdled and killed in the process, or the crown may be girdled causing tree death. Larval feeding sites predispose the root system to infection and girdling by *Phytophthora* spp., thereby exacerbating economic loss. The rootstocks trifoliate orange and hybrid Swingle citrumelo are resistant to the complex of *P. nicotianae* and Diaprepes root weevil, while Cleopatra mandarin is susceptible to this complex. When *P. palmivora* is coincident with *P. nicotianae* in fine-textured, poorly drained soils, Swingle citrumelo is more vulnerable to attack by the complex than is Cleopatra mandarin. See also chapter 31, Phytophthora Foot Rot, Crown Rot, and Root Rot.

Pest Management

Methods of Sampling Root Weevil Larvae and Adults

The population abundance and distribution of endemic citrus root weevils, regardless of species, vary from grove to grove, within a grove, and within a season. The seasonal abundance of adults within a citrus grove can be monitored using ground traps to capture emerging adults or via visual sighting of adults in the tree. No methods exist for monitoring larvae in the soil. By monitoring adult emergence using traps, the approximate time and intensity of adult emergence can be estimated for each infestation. By knowing the species of weevil and their seasonal emergence pattern from soil, a grower can apply adult control measures when weevil populations are highest. Research suggests that adult emergence often coincides with the onset of summer rains in late May through June, soil temperature increasing, and the summer flush in central Florida groves.

Cultural Considerations

Citrus root weevil management begins with the selection of a phytophthora-resistant rootstock that is certified weevil-free. Optimal soil drainage is fundamental to citrus root weevil management, particularly in heavier soils common to the coastal and interior flatwoods where insect and pathogen populations are highest. Tree decline associated with Diaprepes distribution is often patchy within groves and most obvious in lowlands. Stressed trees frequently harbor higher populations of adults because these stressed trees frequently generate more leaf flushes as food for adults. Spot-treating these locations with a chemical or biological agent should help. Regular fertilization and irrigation are crucial to new root growth in weevil-infested groves. Fertigation at monthly intervals has been used by growers to promote the growth of fibrous roots after Diaprepes has destroyed the taproot and inner crown of the tree. Skirt pruning and trunk banding can be effective in controlling flightless weevil species. Weed control is also needed to prevent movement into trees from stems of grasses and/or broadleaf weeds. Weed control is probably beneficial in reducing populations of alternate host plants. **The use of sound cultural practices by the grower should be adequate for managing all citrus root weevils on mature trees except for the Diaprepes root weevil and blue-green citrus root weevils.**

A wide range of parasites, predators, and pathogens attack citrus root weevils at one or more developmental stages within the tree canopy or in the soil. Most of these natural enemies are widely distributed and are general feeders. When focusing on cultural tactics favoring tree health and not using chemical methods, growers are conserving and augmenting the natural enemies of citrus root weevils.

Pest Control Considerations

Pest management of Diaprepes and, to a lesser extent, other citrus root weevils must begin with control of different life stages, particularly adult weevils, using the following options: (1) foliar sprays for egg and adult suppression, (2) chemical barriers for larval control, and (3) biological control of all subterranean stages with nematodes. The application of these control tactics is timed according to monitoring of adult emergence and the onset of leaf flushing in the spring/summer period. Any of these tactics should reduce root injury and help sustain root health from grove to grove. For many groves, however, pest management might differ according to (1) rootstock susceptibility to soilborne diseases (i.e., *Phytophthora* spp.) and (2) root stress caused by excessive flooding and poor drainage of sandy loam soils. In certain grove situations, a soil fungicide for control of *Phytophthora* spp. should be advised (see fungicide section below).

Newly planted resets and groves younger than 5 years old with an established Diaprepes infestation on a susceptible rootstock can decline within 2 years without adult and/or larval control. A similar grove situation involving a resistant rootstock will have lesser tree decline but will require adult suppression. **Remember, groves planted on deep, sandy soils will often require no supplemental control and can rely on biological control agents.**

Foliar sprays of different contact (knockdown) insecticides that include petroleum oil to improve residual effect are used to target adult weevils in the tree canopy. Although foliar sprays have been used by growers to suppress adults any time of the year, research in central Florida has shown conclusively that root injury is lessened and overall tree health improved when two foliar sprays are used 4 weeks apart during peak summer flush in late May through June, along with an egg sterilant in the last application. The purpose of adult suppression with foliar sprays is to limit the number of gravid females and egg deposition, thereby reducing the number of larvae entering the soil. An egg sterilant such as Micromite 80WGS has a 6-week residual effect, during which females lay sterile eggs and eggs contacting the leaf surface are nonviable. The addition of petroleum oil to the spray mixture affects the bonding characteristics of the substance bonding the egg mass to the leaf.

Multiple applications of most foliar sprays within a season can incite an abnormal increase in spider mite populations; any pesticide, when used frequently, might cause secondary pest outbreaks or lead to resistance.

A chemical barrier applied as a band to the soil surface beneath the tree through an herbicide applicator provides a treated surface that will kill newly hatched invasive larvae before they reach the root system. The chemical must be uniformly applied from the trunk to the dripline of the tree to a moistened soil surface devoid of litter. Greater spray volume (~40 gal/ac) should ensure greater uniformity of coverage. Disturbance of the soil beneath the trees should be minimized to protect the soil barrier. Because neonates are killed upon exposure to treated soil as they pass through the barrier, this control tactic is best used for resets and young plantings infested with phytophthora and, where root injury by larvae must be minimal.

Timing chemical application to the time of year when larval entry into the soil is highest requires monitoring of adult weevils in the tree. Because highest larva recruitment occurs just after peak adult emergence, growers should apply soil treatment in early July, about 2 weeks after peak adult emergence in central Florida. Peak adult emergence is generally 2 to 3 weeks earlier in coastal groves.

Currently, Brigade WSB, a synthetic pyrethroid, is the only chemical registered for neonatal larvae control and applied as a soil barrier. Brigade has about 3 weeks residual presence in the soil and will suppress ants foraging on the soil surface. Generally, ant predators will recover after 30 days.

Physical barriers consisting of landscape fabric on the soil surface were shown experimentally to be highly effective in preventing the newly hatched larvae from entering the soil and newly developed adults from escaping beneath the fabric. These barriers have been used for weevil management in California and Texas with some success and are increasingly employed in Florida on both flat-ground and raised beds. In addition to weevil management, the fabric has been shown to conserve water use and increase root and tree growth rates. Various ground-cover fabric products have been used in citrus trials (e.g., Lumite, Ultraweb 3000), but it is critical to use a product with high water infiltration rate to avoid irrigation runoff. The cost of the fabric and installation is high, but the savings in reduced water use and weed and insect pest management, as well as better tree growth and reduced weevil damage, would potentially make the treatment profitable where weevil damage is high.

The use of individual protective tree covers (IPC) for psyllid management will also prevent adult Diaprepes from laying eggs on young trees. Protecting trees from both huanglongbing and Diaprepes root feeding during the first several years, when trees are most susceptible to damage, makes the use of these devices an especially promising IPM tactic.

Parasitic nematodes that specifically attack insects are infectious to all larval stages of citrus root weevils. They are naturally found in citrus soils, where they inflict mortality to all weevil life stages they contact. Depending on availability, nematodes are also sold as biopesticides to control citrus root weevil larvae. They should be applied during months when soil surface temperatures are expected to exceed 70°F. Weevil larvae are generally most abundant in the soil during the summer (mid-July through September); therefore, one or more nematode applications are recommended at this time of year if soil moisture via natural causes and/or irrigation is adequate. Nematodes should not be applied within 4 weeks of nematicide use. Properly modified herbicide applicators or microsprinkler irrigation systems are used to deliver nematodes into premoistened soil. Application of approximately one acre-inch of water should also be applied to the irrigated acre immediately following application. Application late in the day or on cloudy days is encouraged to reduce nematode desiccation and exposure to lethal UV radiation.

Nematode products are most effective when applied in sandy soils with coarser soil texture and are less effective in very fine-textured soils at recommended rates. Higher rates can be applied to very fine-textured soils.

A fungicide for control of *Phytophthora* spp. may be recommended under the following conditions as a supplemental strategy to larval and adult weevil control: (1) the soils are fine-textured, poorly drained, or high in pH and calcium carbonate; (2) the trees are on rootstocks susceptible to *Phytophthora* spp.; and (3) populations are above the damaging levels (20 and 40 propagules per cm^3 soil) for *P. nicotianae* and *P. palmivora*, respectively. Remember, larval and/or adult weevil control must be effective before fungicide treatment is justified.

Recommended Chemical Controls

READ THE LABEL.

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 and biological controls for citrus root weevils.

IRAC MOA[1]	Pesticide Trade Name	Rate/Acre[2]	Comments	Pests Controlled
Parasitic Nematodes				
NR	**Nemasys® R**			
	Nemasys® R	18,000–40,000 nematodes or greater per square foot	Nemasys® R contains live nematodes to reduce *Diaprepes* and *Pachnaeus* spp. subterranean stages. Make one or more applications per year when soil tempertures exceed 70°F. Apply through microirrigation or through herbicide boom to moist soil; one-half to one inch irrigation is needed after application.	**Root weevils**
Soil Barrier				
3	**Bifenthrin**			
	Brigade WSB	0.25–0.5 lb a.i.	*Restricted use pesticide. Apply uniformly to moist, weed-free soil. Do not apply via irrigation. Do not exceed 32 oz per season.	**Root weevils**, fire ants, Asian cockroach
Foliar Spray				
1 A	**Carbaryl**			
	Sevin 4 F + Petroleum Oil 97+% (FC435-66, FC 455-88, or 470 oil)	1–2 gal + 1 gal oil	Contact/residual foliar spray. Lower rates will result in reduced residual activity. Do not exceed 20 lb a.i./acre/year for all uses. Do not exceed 2 applications per season. May increase spider mite populations. Do not apply when temperature exceeds 94°F. 470 weight oil has not been evaluated for effects on fruit coloring or ripening. Heavier oils are more likely to be phytotoxic than lighter oils.	**Root weevils**, orange dog, katydids, grasshoppers, crickets, scale
	Sevin XLR + Petroleum Oil 97+% (FC435-66, FC 455-88, or 470 oil)	1–2 gal + 1 gal oil		
1 B	**Phosmet**			
	Imidan 70 WP	1–2 lb	Contact foliar spray.	**Root weevils**
3	**Fenpropathrin**			
	Danitol 2.4 EC	16–21 oz	*Restricted use pesticide. Contact foliar spray. Do not apply when temperatures exceed 94°F.	**Root weevils**, thrips, citrus psyllid
15	**Diflubenzuron**			
	Micromite 80 WGS + Petroleum oil 97+% (FC435-66, FC 455-88, or 470 oil)	6.25 oz + 1 gal oil	*Restricted use pesticide. Residual foliar spray. Maximum of 3 applications per season. Do not apply when temperature exceeds 94°F. 470 weight oil has not been evaluated for effects on fruit coloring or ripening. Heavier oils are more likely to be phytotoxic than lighter oils. Do not combine with Boron within 21 days to harvest.	**Root weevils**, citrus leafminer, citrus rust mites

[1] Mode of action class for citrus pesticides from the Insecticide Resistance Action Committee (IRAC) Mode of Action Classification V.10.1 (2021).
[2] Lower rates may be used on smaller trees. Do not use less than the minimum label rate.