PP-156

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2011 Florida Citrus Pest Management Guide: Phytophthora Foot Rot and Root Rot[1]

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Foot rot results from infection of the scion near the ground level, producing bark lesions which extend down to the budunion on resistant rootstocks. Crown rot results from infection of the bark below the soil line when susceptible rootstocks are used. Root rot occurs when the cortex of fibrous roots is infected, turns soft and appears water-soaked. Fibrous roots slough off their cortex leaving only a white thread-like stele (inner tissue of the fibrous root). Foot rot and root rot can be caused by *P. nicotianae* or *P. palmivora*. When managing Phytophthora-induced diseases, consider integration of cultural practices (e.g., disease exclusion through use of Phytophthora-free planting stock, resistant rootstocks, proper irrigation practices) and chemical control methods. Phytophthora management with chemical control should not be considered until other potential causes of decline in tree production are evaluated and corrected. See also ENY-606 Nematodes.

Cultural Practices to Manage *P. nicotianae*

Field locations not previously planted with citrus are probably free of citrus-specific *P. nicotianae*. Planting stock may be tested for freedom from *Phytophthora* spp. in the nursery and inspected for fibrous root rot in the nursery or grove before planting. In groves with a previous history of foot rot, consider use of Swingle citrumelo for replanting. Swingle citrumelo is normally resistant to foot rot and roots do not support damaging populations once trees are established. Cleopatra mandarin should be avoided because it is prone to develop foot rot when roots are infected in the nursery or when trees are planted in flatwoods situations with high or fluctuating water tables and fine-textured soils. Trees should be planted with the budunion well above the soil line and provided with adequate soil drainage. Overwatering, especially of young trees, promotes buildup of *Phytophthora* populations in the soil and increases risk of foot rot infection. Prolonged wetting

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of the trunk, especially if tree wraps are used on young trees, should be avoided by using early to midday irrigation schedules. Control of fire ants prevents their nesting under wraps and feeding damage to moist, tender bark, which is then susceptible to infection.

Sampling for *P. nicotianae*

Population densities of the fungus in grove soils should be determined to assist decisions to treat with fungicides. Soil samples containing fibrous roots should be collected during the spring through fall (March to November) from under the canopy within the tree dripline. Individual small amounts of soil from 20 to 40 locations within a 10-acre area are composited into one resealable plastic bag to retain soil moisture. Samples must be kept cool but not refrigerated for transport to the analytical laboratory. Currently, populations in excess of 15 to 20 propagules per cm^3 soil of *P. nicotianae* are considered damaging. The same soil sample should be tested for populations of nematodes, to assess whether they occur at damaging levels.

Larval feeding injury to citrus roots and its relationship to invasion by *Phytophthora* spp.

Association of Phytophthora root rot with root damage by larvae of *Diaprepes abbreviatus* has been called the Phytophthora-Diaprepes (PD) complex (see ENY-611 Citrus Root Weevils or the Diaprepes Root Weevil task force website). Surveys have identified a far more severe interaction of *P. palmivora* with Diaprepes root weevil than where *P. nicotianae* is the predominant interacting pathogen. The damage caused by *P. palmivora* is often associated with poorly-drained, fine-textured soils and rootstocks normally tolerant of *P. nicotianae*, Swingle citrumelo and Carrizo citrange. In the more severe form, structural roots collapse from what appears to be moderate larval damage followed by aggressive spread of *P. palmivora* through the roots. Because trees on Swingle citrumelo are more severely affected by the Diaprepes root weevils than surrounding groves on sour orange, there is a particular concern about young plantings on Swingle citrumelo that replace blocks on sour orange. Swingle citrumelo consistently supports higher soil populations of *P. palmivora* than trees on Cleopatra mandarin or sour orange.

Rootstock susceptibility to damage by the PD complex depends on which *Phytophthora* spp. is present and whether the soil and water conditions are conducive to the fungus or to rootstock stress. In most situations, *P. nicotianae* is the predominant pathogen and Swingle citrumelo appears to perform acceptably as a replant in weevil-infested groves, provided soil conditions are suited for this rootstock (e.g., sandy soil texture, well-drained, favorable pH and calcium carbonate status, etc.). When *P. palmivora* is present in poorly-drained soils high in clay, pH and calcium carbonate, Diaprepes root weevils render normally tolerant Swingle citrumelo and Carrizo citrange susceptible to Phytophthora root rot infection. Thus, tolerance of Swingle citrumelo is restricted to the ridge and certain flatwoods soils.

Chemical Control

Use of fungicides in young groves should be based on rootstock susceptibility, likelihood of Phytophthora infestation in the nursery, and history of Phytophthora disease problems in the grove. For susceptible rootstocks, such as Cleopatra mandarin and sweet orange, fungicides may be applied to young trees on a preventive basis for foot rot. For young trees on other rootstocks, fungicide treatments should commence when foot rot lesions develop. The fungicide program for foot rot should be continued for at least one year for tolerant rootstocks, but may continue beyond the first year for susceptible stocks. In mature groves, the decision to apply fungicides for root rot control is based on yearly soil sampling to indicate whether damaging populations of *P. nicotianae* occur in successive growing seasons. Time spring and fall applications to coincide with periods of susceptible root flushes in the spring (after the spring leaf flush) and fall (October to November). Soil application methods with fungicides should be targeted to undercanopy areas of highest fibrous root density. To avoid leaching from the root zone, soil-applied fungicides should not be followed by excessive irrigation. Aliette and Ridomil are both effective, but alternation of the materials should be practiced to minimize the risk of the development of fungicide resistance.

Management of the Phytophthora-Diaprepes Complex

Selection of tolerant rootstocks for replanting Diaprepes root weevil-affected groves aids in management of future losses. For existing trees, fungicides in conjunction with careful water and fertilizer management have been utilized to maintain tolerance to Diaprepes root weevil and Phytophthora damage. Fertigation maximizes efficiency of water and nutrient uptake by the roots in well-drained soils. However, use of fertigation to regenerate roots is limited in poorly-drained soils and high water tables typical in the flatwoods. In these situations, there may be increased reliance on fungicides to control root damage by *Phytophthora* spp.

Based on studies of the PD complex, aggressive control of Diaprepes root weevil larvae and adult stages should be implemented as soon as infestation is discovered to minimize the more severe Phytophthora damage that follows larval feeding on roots. The IPM program may include carefully scheduled fertigation in well-drained soils to promote regeneration of fibrous roots after damage. In the flatwoods, IPM may include use of fungicides under the following conditions: 1) the soils are fine textured, poorly-drained or high in pH and calcium carbonate status, 2) the trees are on rootstocks susceptible to either or both *Phytophthora* spp., and 3) populations are above the damaging levels (15 to 20 and 40 propagules per cm^3 soil for *P. nicotianae* and *P. palmivora*, respectively). A key to assist growers making Phytophthora-Diaprepes management decisions is available at http://www.crec.ifas.ufl.edu/extension/diaprepes/key.htm.

Fungicides are not recommended for Phytophthora control in citrus nurseries.

Recommended Chemical Controls

READ THE LABEL.

See Tables 1 and 2.

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 Phytophthora Foot Rot and Root Rot – Fosetyl AL and Phosphite Salts Products.

Pesticide	FRAC MOA[1]	Mature Trees Rate/Acre[2]	Method of Application	Comments
Aliette WDG[3,4]	33			Protectant and curative systemic. Buffering to pH 6 or higher is recommended to avoid phytotoxicity when copper has been used prior to, with, or following Aliette.
Nonbearing		5 lb/100 gal.	Foliar spray	
		2.5-5 lb/5 gals	Trunk paint or spray[5]	
		Up to 5 lb/acre	Microsprinkler	Adjust rate according to tree size
Bearing		5 lb/acre or 1 lb/100 gal	Foliar spray in 100-250 gal/acre. Do not exceed 500 gal/acre.	Apply up to 4 times/year (e.g., March, May, July and September) for fibrous root rot control.
		5 lb/10 gal/acre	Aerial	Fly every middle. Do not apply in less than 10 gal/acre
		5 lb/acre	Surface spray on weed-free area followed by 0.5 inch irrigation or by microsprinkler in 0.1-0.3 inch of water.	Apply up to 4 times/year (e.g., March, May, July and September) for fibrous root rot control.
Phostrol	33			Protectant and curative systemic. Do not apply when trees are under water stress or high temperature conditions.
Bearing or Nonbearing		4.5 pt/acre	Foliar spray	Apply up to 4 times/year (e.g. March, May, July and September).
Bearing or Nonbearing		2-5 pt/5 gal	Trunk paint or spray	Trunk paint or spray
ProPhyt	33			Protectant and curative systemic. Do not apply when trees are under water stress or high temperature conditions.
Nonbearing		2 gal/100 gal	drench	1/2 pt solution per seedling in 2 gallon pot; can be applied through microsprinkler
Bearing		4 pt/acre	Foliar spray	Apply up to 4 times/year (e.g., March, May, July and September) for fibrous root rot control.

[1]Mode of action class for citrus pesticides from the Fungicide Resistance Action Committee (FRAC) 2010. Refer to ENY624, 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]For combinations of application methods, do not exceed 4 applications or 20 lb/acre/year.

[4]Fungicide treatments control fibrous root rot on highly susceptible sweet orange rootstock, but are not effective against structural root rot and will not reverse tree decline.

[5]Apply in May prior to summer rains and/or in the fall prior to wrapping trees for freeze protection.

Table 2. Recommended Chemical Controls for Phytophthora Foot Rot and Root Rot – Mefenoxam and Copper Products.

Pesticide	FRAC MOA[1]	Mature Trees Rate/Acre[2]	Method of Application	Comments
Ridomil Gold SL[3,4]	4			Protectant and curative systemic. Do not apply tank mixes of Ridomil and residual herbicides to trees less than 3 years old. Apply herbicide first, then wait 3-4 weeks to apply Ridomil.
Nonbearing		1 qt/acre of treated soil surface	Surface spray on weed-free area, followed immediately by 0.5 inch irrigation or by microsprinkler in 0.1-0.3 inch of water.	Apply every 3 months for maximum control; in most cases a late spring and late summer application should be sufficient.
		1/2 pt/grove acre	Through irrigation injection	
		1-1.5 oz/100 gal	Soil drench; apply 5 gal of mix in water ring.	Apply every 3 months for maximum control; in most cases a late spring and late summer application should be sufficient.
Bearing		1 pt/acre of treated soil surface if <20 propagules/cm^3 soil 1 qt/acre of treated soil surface if >20 propagules/cm^3 soil	Surface spray on weed-free area, Followed immediately by 0.5 inch irrigation or microsprinkler in 0.1-0.3 inch of water.	Apply 3 times/year (late spring, summer, early fall).
		1/2 pt/grove acre <20 propagules/cm^3 soil 1 pt/grove acre >20 propagules/cm^3 soil	Through irrigation injection	
Bearing or Nonbearing		1 qt/10 gal	Trunk paint or spray	May be applied up to 3 times/yr.
Ridomil Gold GR[2]	4			
				Do not apply Ridomil Gold GR and residual herbicides to trees less than 3 years old simultaneously. Apply herbicide first, then wait 3-4 weeks to apply Ridomil. Do not apply more than 240 lb of Ridomil Gold GR/acre/year
Nonbearing		40-80 lb/acre of treated soil surface	Broadcast application under the canopy. If rain not expected for 3 days, follow by 0.5-1.0 inch of irrigation.	Apply every 3 months for maximum control; in most cases a late spring and late summer application should be sufficient.

Table 2. Recommended Chemical Controls for Phytophthora Foot Rot and Root Rot – Mefenoxam and Copper Products.

		1-1.5 oz/tree	In water ring. Within 3 days of application, apply 5 gal water/tree.	Apply every 3 months for maximum control; in most cases a late spring and late summer application should be sufficient.
Bearing		40-80 lb/acre of treated soil surface	Broadcast application under the canopy. If rain not expected for 3 days, follow by 0.5-1.0 inch of irrigation.	Apply 3 times/year (late spring, summer, early fall).
UltraFlourish[3,4]	4			Protectant and curative systemic. Do not apply tank mixes of UltraFlourish and residual herbicides to trees less than 3 years old. Apply herbicide first, then wait 3-4 weeks to apply UltraFlourish.
Nonbearing		2-4 qt/acre of treated soil surface	Surface spray on weed-free area, followed immediately by 0.5 inch irrigation or by microsprinkler in 0.1-0.3 inches of water.	Apply every 3 months for maximum control; in most cases a late spring and late summer application should be sufficient.
		1 pt/grove acre	Through irrigation injection	
		2-3 oz/100 gal	Soil drench; apply 5 gal of mix in water ring.	Apply every 3 months for maximum control; in most cases a late spring and late summer application should be sufficient.
Bearing		1 qt/acre of treated soil surface <20 propagules/cm^3 soil 2 qt/grove acre >20 propagules/cm^3 soil	Surface spray on weed-free area, followed immediately by 0.5 inch irrigation or microsprinkler in 0.1-0.3 inch of water.	Apply 3 times/year (late spring, summer, early fall).
		1 pt/grove acre	Through irrigation injection	
Copper-Wettable Powder	M1	0.5 lb (metallic) Cu/1 gal water	Trunk paint[5]	Protectant
Copper-Count-N	M1	1 qt in 3 qt water	Trunk paint[5]	Protectant. Do not apply to green bark; may cause gumming.

[1]Mode of action class for citrus pesticides from the Fungicide Resistance Action Committee (FRAC) 2010. Refer to ENY624, 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]Do not exceed the equivalent of 6 lb a.i./acre/year of mefenoxam-containing products.

[4]Do not apply to bare roots or higher than 1 qt/acre of treated soil surface to citrus resets or trees less than 5 years old to avoid potential phytotoxicity.

[5]Apply in May prior to summer rains and/or in the fall prior to wrapping trees for freeze protection.