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2026–2029 Florida Citrus Production Guide: Phytophthora Foot Rot, Crown Rot, and Root Rot[1]

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Foot rot results from scion infection near the ground level, producing bark lesions that extend down to the bud union on tolerant rootstocks. Crown rot results from bark infection 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, crown rot, and root rot can be caused by *Phytophthora nicotianae* or *P. palmivora*. When managing phytophthora-induced diseases, integration of chemical control methods and cultural practices (e.g., disease exclusion with phytophthora-free planting stock, tolerant rootstocks, proper irrigation practices [see chapter 13, "Irrigation Management of Citrus Trees"]) is necessary. Phytophthora management with chemical control should not be considered until other potential causes of decline in tree production are evaluated and corrected. See also chapters (39, 28, and 27, respectively) on "Blight," "Huanglongbing (Citrus Greening)," and "Nematodes." The decision to treat should follow soil sampling to determine how much phytophthora is present in the soil. Details are given below.

Cultural Practices to Manage *P. nicotianae*

Field locations not previously planted with citrus are probably free of citrus-specific *P. nicotianae.* Planting stock should be free from *Phytophthora* spp. in the nursery, and inspection for fibrous root rot in the nursery or grove before planting is advised. If uncertain, testing of nursery stock for *Phytophthora* spp. is recommended. In groves with a previous history of foot rot, consider use of Swingle citrumelo or other tolerant rootstocks (see *Florida Citrus Rootstock Selection Guide*) for replanting. Tolerance to *Phytophthora* spp. can be compromised when planted in unfavorable soils for the rootstock (e.g., Swingle citrumelo in calcareous soils). Rootstocks tolerant to foot and root rot normally do not support damaging populations once trees are established. Cleopatra mandarin should be used with caution because it is prone to developing crown and 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. When resetting, never use Cleopatra mandarin in a grove with a history of damaging phytophthora, regardless of region. Plant trees with the bud union more than 6 inches above the soil line and provide adequate soil drainage. Additionally, care should be taken to ensure the planting hole is adequately sized for the root system to avoid root damage. Overwatering, especially of young trees, promotes buildup of phytophthora populations in the soil and increases risk of foot rot infection. Prolonged wetting 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 trunk wraps and feeding damage to moist, tender bark, which is then susceptible to infection.

Sampling for *Phytophthora* Spp.

Determine population densities of the fungus-like organism in grove soils to assist decisions of whether to treat with fungicides. Collect soil samples containing fibrous roots from March to November from under the canopy within the irrigated zones. When sampling trees of average canopy condition, combine individual small amounts from the top ten inches of soil from 20 to 40 locations in the microsprinkler zones within a 10-acre block into one resealable plastic bag to retain soil moisture. Samples must be kept cool but not refrigerated for transport to an analytical laboratory. Currently, populations in excess of 10 to 20 propagules per cm^3 soil of total *Phytophthora* spp. (*P. nicotianae* + *P. palmivora*) are considered damaging. The same soil sample should be tested for populations of nematodes to assess whether they occur at damaging levels.

Chemical Control

Use of fungicides in young groves should be based on rootstock susceptibility, likelihood of *Phytophthora* spp. 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 for foot rot on a preventive basis. 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 rootstocks. In mature groves, the decision to apply fungicides for root rot control is based on yearly soil sampling to determine whether damaging populations of *P. nicotianae* occur in successive growing seasons. Timing of applications should coincide with periods of susceptible root flushes after the spring leaf flush, usually from late spring to early summer and after the fall leaf flush in October to November. Soil application methods with fungicides should be targeted to irrigated areas under the canopy with the highest fibrous root density. To avoid leaching from the root zone, soil-applied fungicides should not be followed by excessive irrigation. Aliette, phosphite salts, Ridomil Gold, or Presidio are effective, but alternation of the materials should be practiced to minimize the risk of the development of fungicide resistance. It is recommended to alternate the soil-applied Ridomil and Presidio on the major spring and fall root flushes as well as to continue to apply Aliette or phosphite salts on a calendar schedule per the label.

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 chapter 26, "Citrus Root Weevils," or the Diaprepes Root Weevil website). A far more severe interaction has been identified between *P. palmivora* and Diaprepes root weevil than for *P. nicotianae*. The damage caused by *P. palmivora* is often associated with poorly drained, fine-textured soils and rootstocks like Swingle citrumelo and Carrizo citrange that are normally tolerant of *P. nicotianae*. 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 structural roots.

Rootstock susceptibility to damage by the PD complex depends on which *Phytophthora* sp. is present and whether the soil and water conditions are conducive to the fungus-like organism 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., favorable pH and calcium carbonate status, sandy soil texture, well-drained, etc.). When *P. palmivora* is present in poorly drained soils high in clay, pH, or 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. For more information about rootstock selection, refer to chapter 11, "Rootstock and Scion Selection", and the *Florida Citrus Rootstock Selection Guide*.

Management of the *Phytophthora-Diaprepes* Complex

Selection of tolerant rootstocks for replanting *Diaprepes* root weevil-affected groves is important for 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 water and nutrient uptake efficiency by 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, high in pH, or calcareous, (2) the trees are on rootstocks susceptible to either or both *Phytophthora* spp., and (3) populations are above the damaging levels (10 to 20 propagules per cm^3 soil). A key to assist growers making *Phytophthora-Diaprepes* management decisions is available at the Diaprepes Root Weevil website as well as the Florida Citrus Rootstock Selection Guide.

Management of the Phytophthora-HLB Interaction

Management of phytophthora root rot is complicated by huanglongbing (HLB; see chapter 28, "Huanglongbing [Citrus Greening]") because the causal bacterium infects all parts of the citrus tree, including the roots. HLB accelerates phytophthora infection and fibrous root damage. HLB predisposes roots to *P. nicotianae* infection apparently by increasing attraction of zoospores to roots, accelerating infection, and lowering resistance to root invasion. The spread of HLB has led to more frequent cases of damaging phytophthora populations. Most recently, there has been a multiyear cycling of phytophthora populations apparently associated with lower fibrous root density and bursts of root growth as trees continue to decline from HLB. This has heightened concern for the root health of HLB-affected trees and initiation of measures to reduce root stress, which includes *Phytophthora* spp., citrus

nematodes, *Diaprepes*, and abiotic soil factors. While all of these factors need to be considered and assessed on a case-by-case basis depending on site and rootstock, specific factors must be considered when controlling phytophthora with high-incidence HLB.

Although HLB causes fibrous root dieback, it also increases new growth of fibrous roots. Similar to leaf flushing, new root growth is no longer as synchronized into flush events. This is important because phytophthora preferentially infects new root growth. Constant availability of new root growth is a likely cause of the rapid development of damaging phytophthora populations under favorable conditions. The cycles of root dieback and root flushing caused by HLB lead to large swings in phytophthora propagule counts in a grove. Preliminary data indicate that chemical management has reduced effectiveness for control of *Phytophthora* spp. and prevention of root loss. Therefore, it is important to monitor phytophthora propagule counts before major summer and fall root growth events. If a damaging population is developing, it is important to time chemical applications to protect those major root flushes.

Web Addresses for Links

Diaprepes Root Weevil: https://citrusresearch.ifas.ufl.edu/pest-management/insects/diaprepes-root-weevil/

Florida Citrus Rootstock Selection Guide: https://ask.ifas.ufl.edu/publication/HS1260

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