

Peach Root-knot Nematode¹

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Introduction

One of the production issues that peach growers in Florida must contend with is plant-parasitic nematodes. Problem nematodes that have been identified on peach include root-knot nematodes (*Meloidogyne* spp.), lesion nematodes (*Pratylenchus* spp.), and ring nematodes (*Mesocriconema xenoplax*). To date, the most important of these three genera of nematodes to Florida peach growers is root-knot nematodes. These nematodes thrive in warm, sandy soils, making it necessary to graft peach scions onto nematode-resistant rootstocks. Root infection by these nematodes results in the decline of peach tree health and reductions in fruit quantity and quality. There are four root-knot nematode species that are important in peach; these are *Meloidogyne incognita* (southern root-knot nematode), *M. javanica* (Javanese root-knot nematode), *M. arenaria* (peanut root-knot nematode), and the more recently discovered *M. floridensis* (peach root-knot nematode). The latter is endemic to Florida. In 1966, *M. floridensis* was first detected infecting peach rootstocks 'Okinawa' and 'Nemaguard' in Gainesville, Florida. The taxonomy of this nematode was initially confused with a variant of the southern root-knot nematode (Sharpe 1967; Sherman and Lyrene 1983), but more recently it has been recognized as a distinct species (Handoo et al. 2004). This publication will focus on the peach root-knot nematode, *Meloidogyne floridensis* (Figure 1).



Figure 1. Root galls caused by root-knot nematode, *Meloidogyne floridensis*.

Credit: Janete Brito, UF/IFAS

Host Range and Distribution

Meloidogyne floridensis is a endoparasitic nematode that feeds and reproduces on the roots of several ornamentals (dracaena, hibiscus, impatiens, and snapdragon), vegetables (cucumber, eggplant, squash, watermelon, and tomato), herbs (verbena, basil, and dill), weeds (morning glory, velvetleaf, amaranth, redroot pigweed, red tassel flower, dichondra, American pokeweed, lion's ear, wild cucumber, and spurge nettle), and fruits (peach). Its distribution in Florida extends from Miami-Dade County northward to Alachua County (Brito et al. 2008; Brito et al. 2010; Church 2005; Kaur et al. 2007; Kokalis-Burelle and Nyczepir 2004). A recent survey conducted by nematologists at the University of Florida and the Division of Plant Industry of 25 Florida peach orchards shows the incidence of peach infected by *M. floridensis* at 36%.

This Florida-endemic species overcomes the resistances in 'Okinawa', 'Nemaguard', 'Nemared', and 'Guardian' peach rootstocks (Esmenjaud et al. 2009; Handoo et al. 2004; Lecouls et al. 1997; Nyczepir and Beckman 2000); therefore, these rootstocks commonly used in major peach production regions in California, Georgia, and the Carolinas are not suitable for commercial peach production in Florida.

Disease Cycle

The life cycle of root-knot nematodes consists of five developmental stages: egg, second- (J2), third- (J3), and fourth-stage (J4) juveniles, and adult. The development time from egg to egg-laying adult is dependent on temperature and soil moisture. The cycle is slower (greater than 5 weeks) during the cooler months and more rapid (3–4 weeks) during warmer months. Eggs readily hatch in warm, moist soils. Periods of increased nematode activity when temperatures are warm (75°F–85°F) during late spring and summer coincide with flushes of the shoot and root growth. Nematodes hatch from the eggs as second-stage juveniles (J2s) that actively seek out and penetrate plant roots. The infective J2s move easily through the interstices of moist, coarse-textured sandy soils and preferentially penetrate the growing root tips. The J2s migrate in-between the root cells and become sedentary once they set up their feeding site at the root vascular cambium. Their feeding stimulates the surrounding tissues

to enlarge and increase in number, forming giant cells that become their "nutrient sinks" for growth into later stages. The formation of root galls is typical of infection by the *Meloidogyne* genus. The galls caused by *M. floridensis* are usually smaller than those produced by *M. javanica*, *M. incognita*, and *M. arenaria*. Each mature female lays several hundred eggs into a protective gelatinous matrix that forms a visible mass on the root surface. The disease cycle continues when a new generation of eggs hatch in warm, moist soil. Roots continue to become infected by later generations of nematodes, increasing the number and size of galls. Nematode population densities, which influence the degree of galling, vary depending on the environmental conditions and rootstock genotype.

Symptoms

Root-knot disease on a peach tree is often overlooked because the infective juvenile is microscopic and dwells underground. Aboveground symptoms of diseased trees generally develop within a year after transplanting seedlings. The severity of the disease manifestation is dependent on the population density of juveniles in the soil. The aboveground symptoms include stunting, yellowing, premature leaf drop, and reduced vigor (Figure 2). The symptoms mock those caused by other factors such as nutrient deficiencies, water stress, and root injuries from other root-damaging pathogens and pests. These symptoms become most apparent near the end of the growing season (late summer or fall) and may be most pronounced when infected trees are under stress from lack of moisture. The leaves turn pale-green to yellowish in color, and older leaves may drop prematurely due to the reduced level of photosynthates to support plant growth. With the reduced foliage and lower carbohydrate reserves in the roots, the following season's fruit yield and quality are reduced on bearing trees grafted on susceptible rootstocks (Figure 3).



Figure 2. Damage symptoms caused by root-knot nematodes on peach. Trees on the left are healthy, but the one on the right shows yellowing, stunting, and reduced vigor.

Credit: Mary Ann D. Maquilan, UF/IFAS



Figure 3. Reduction in foliage is resulting in the production of poor quality fruit.

Credit: Mary Ann D. Maquilan, UF/IFAS

Vascular disruption, i.e., differentiation of root parenchyma cells into enlarged and specialized feeding cells seen as knot-like galls, impairs root function and results in disease symptoms as described above. The root-knot disease can be confirmed by the visible appearance of root galls. However, once roots become infected, it is difficult to treat for the problem and the tree health deteriorates. In 'Flordaguard' roots, the nematode galls on infected roots are smaller than those observed on susceptible rootstocks, and there is a tendency for excessive lateral root formation to replace the damaged terminal root apices. Such compensatory root growth could be the reason why trees on 'Flordaguard' rootstock are able to withstand nematode pressure. Application of fertilizers will not eliminate the nematodes but will help alleviate the nutrient stress so long as there are sufficient new feeder roots that can function for water and nutrient absorption. The severity and progression of disease symptoms depend on the nematode population density, plant age, the presence of other stress factors (e.g., inadequate moisture and fertilization), rooting volume, the susceptibility of the rootstock, and cultural practices.

Management

Nematode Assessment

It is important to know the previous cropping history of a site being prepared for a peach orchard. One of the best indicators to determine whether the root-knot nematodes are likely to be a potential problem is to obtain information on the previous crop. If a previous plant encountered root-knot nematode problems, such as galled roots, population density of the nematode in the soil is high enough to cause economic damage to the following peach tree. In Florida peach orchards, any of the four species of root-knot nematodes (*M. incognita*, *M. arenaria*, *M. javanica*, and *M. floridensis*) may be present. Since each of these species is known to have a wide host range, it is difficult to assess the potential of these nematode populations to infect peach rootstocks. That is why, if possible, it is best to avoid planting in a known root-knot nematode-infested site.

Whether planting peach seedlings in abandoned citrus grove sites or planting on new ground, the assessment of a potential root-knot nematode problem is best determined from the previous cropping history. If plants, including weeds, were galled by root-knot nematodes, this should be considered in the management assessment. Developing a peach orchard in a root-knot nematode-infested site is especially problematic and should be avoided if at all possible.

Collecting and analyzing soil samples from peach orchards before planting peach trees is another important method to assess potential nematode problems. If juveniles of root-knot nematodes are extracted from the soil, this indicates a potential disease problem, but if no juveniles are recovered it does not mean there is no occurrence or potential root-knot disease. In fact, nematodes harmful to peach are difficult to predict based on soil sample analysis. Root-knot nematodes occur in a patchy distribution, and they often lie hidden deep within the soil profile, occasionally being missed when the soil sample is collected. In addition, the assay may detect the presence of root-knot nematode juveniles, but it does not provide information on the species identification or population density.

The [University of Florida Nematode Assay Lab](https://entnemdept.ufl.edu/nematology-assay-lab/) has provided special instructions for sampling:

Sample submission form:

<https://entnemdept.ufl.edu/nematology-assay-lab/payments-and-forms/>

Sampling instructions:

<https://entnemdept.ufl.edu/nematology-assay-lab/collecting-samples-from-fruit-and-nut-trees/>

Resistant Rootstocks

It is difficult to manage nematodes once they are established in the soil. For perennial crops, use of nematode-resistant rootstocks is currently considered a treatment that provides economically viable, long-term management. Standard rootstocks in the southeastern United States, such as 'Nemaguard', 'Nemared', and 'Guardian', are believed to be susceptible to the endemic *M. floridensis*. Currently, only 'Flordaguard' peach rootstock (Sherman et al. 1991) has been suggested for commercial low-chill peach production in root-knot nematode infested, non-alkaline soils in Florida. This rootstock has the combined nematode resistance and good horticultural features from 'Okinawa' peach and Chinese wild peach (*Prunus davidiana*). However, it is important to note that populations of *M. floridensis* with the ability of infecting 'Flordaguard' rootstock exist in Florida. The distribution of these resistance-breaking populations remains unknown.

'Sharpe' plum hybrid rootstock also has resistance to root-knot nematodes but is recommended only for backyard

and dooryard orchards. This hybrid rootstock is compatible with many peach, nectarine, and plum varieties, but not with apricot. An interspecific peach-plum hybrid rootstock 'MP-29' offers attributes lacking in 'Flordaguard'. It has additional resistance to predominant pathogens in the Southeast such as *Armillaria* root rot (<https://ipm.ucanr.edu/home-and-landscape/armillaria-root-rot/pest-notes/#gsc.tab=0>) and peach tree short life disease

(<https://www.clemson.edu/extension/peach/commercial/diseases/files/h7.4.pdf>). Under field conditions in Byron, Georgia, trees on 'MP-29' showed higher yield efficiency (higher yields with smaller trunk cross-sectional area) than those on 'Guardian' and 'Sharpe' rootstocks (Beckman et al. 2012). 'MP-29' rootstock is currently under field evaluation for commercial use in Florida. For more details about rootstocks for Florida stone fruits, see <https://edis.ifas.ufl.edu/hs366>.

Chemical Management

In combination with resistant rootstocks, soil fumigant nematicides may be applied pre-plant to reduce nematode population densities sufficiently to allow peach roots to become established. Telone II (1,3-dichloropropene) and Vapam (metam sodium) formulations currently are the only two pre-plant soil fumigants labeled for peach growers in the Southeastern United States. These are usually applied to 6–8 ft row strips rather than broadcasted in order to reduce application costs. These chemicals also provide some reduction of other nematodes pathogenic to peach including ring (*Mesocriconema xenoplax*) and lesion (*Pratylenchus* spp.) nematodes. Metam sodium may be applied in combination with Telone II and chloropicrin depending on the soilborne pest-pathogen infestation. Application of such pre-plant fumigants helps young trees become established, while nematode populations are suppressed for about a year. Current pre-plant fumigant recommendations for managing root-knot nematodes in peach orchards are provided in the following table.

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Table 1. Pre-plant chemical control options for the southeastern United States.

PESTS	MATERIALS	RATE/ACRE	EFFECTIVENESS*
Ring nematodes	1,3-dichloropropene (Telone II)	27–35 gallons	++++
Root-knot nematodes			
Root-lesion nematodes			
REMARKS: Telone II is a federally restricted use pesticide. Carefully abide by all label precautions and review the label before applying the product. Telone II may be used when soil temperatures are from 40°F to 80°F at the prescribed injection depth (a minimum of 12 inches). Thorough soil preparation is required, and soil moisture is a critical consideration. If it is too dry, the soil surface will not seal sufficiently to prevent premature dissipation. If the soil is too wet, the product is less effective because it will not move as well in the soil. Excessive soil moisture can also prolong desired dissipation from the soil, which forces a delay of planting to avoid phytotoxicity.			
Soil temperatures of 40°F to 80°F are required for the use of Telone II. However, the product is more active at the upper end of this temperature range. In the southeast, applications should generally be made in the fall prior to mid-November. October soil temperatures often provide the best conditions for efficacy.			
Peach seedlings may be stunted or killed by Telone II if planting takes place too soon after application. Adhere to a pre-plant interval of 4 weeks from application to planting for the 27 gallons per acre (gpa) rate and five weeks for the 35 gpa rate. If soils are wet or they have a clay component, dissipation will be much slower. Plan for at least 6–8 weeks between fumigation and planting; even more time may be necessary. Before planting, use a soil probe to check the soil at the full depth of injection; if the odor of Telone II is present, dissipation is not complete, and it is too early to plant. Cultivation at a depth not to exceed the depth of Telone II application, with subsoil shanks, a middle buster or other implements, will hasten dissipation of Telone II. More than one cultivation may be required to get Telone II out of the ground pre-plant.			
Ring nematodes	Metam sodium	75 gallons	+++
Root-knot nematodes	(Vapam), Sectagon II, Busan 1020		
Root-lesion nematodes			
Notes: Adapted from "Southeastern Pest Management Guide for Peach, Plum, and Nectarine," by B. Blaauw, P. Brannen, B. Bellinger, D. Lockwood, and D. Ritchie (eds.), 2018, p. 64.			
*Efficiency ratings range from +, slightly effective, to +++, highly effective.			

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