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Guava Root-Knot Nematode or Pacara Earpod Root-Knot Nematode Meloidogyne enterolobii (Yang and Eisenback, 1983) (Nematoda: Chromadorea: Rhabditida: Tylenchina: Tylenchomorpha: Tylenchoidea: Meloidogynidae)[1]

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The Featured Creatures collection provides in-depth profiles of insects, nematodes, arachnids, and other organisms relevant to Florida. These profiles are intended for the use of interested laypersons with some knowledge of biology as well as academic audiences. This Featured Creature article profiles Meloidogyne enterolobii (guava root-knot nematode), an invasive plant-parasitic nematode important not only in Florida, also globally.

Introduction

Meloidogyne enterolobii (guava root-knot nematode) is an emerging tropical and subtropical pest. It was described by Yang and Eisenback (1983) but may have previously been misidentified as other root-knot nematode species. *Meloidogyne enterolobii* has the ability to overcome many resistant genes commonly deployed in crops and is particularly damaging, which makes it of particular concern for agricultural production.

Synonymy

Meloidogyne mayaguensis (Rammah and Hirschmann, 1988)

Distribution

Meloidogyne enterolobii was first described from the pacara earpod tree (*Enterolobium contortisiliquum*) in Hainan Island in China in 1983 (Yang and Eisenback, 1983). While it is mainly found in tropical and subtropical areas, with its recent detection in Australia (Bond et al., 2024), it has been detected in every inhabited continent (Castillo and Castagnone-Sereno, 2020). *Meloidogyne enterolobii* is still emerging in most locations and typically has a geographically limited distribution within countries. For example, it was first reported in the United States in 2004 in Florida (Brito et al., 2004) and has been reported in most counties in Florida (Brito et al., 2008, 2010). It has since been reported in North Carolina (Ye et al., 2013), South Carolina (Overstreet et al., 2019), Louisiana (Rutter et al., 2019), and Texas (Nunes Rondon et al., 2025).

Description

Morphologically, *Meloidogyne enterolobii* is very similar to other root-knot nematode species and requires training to differentiate nematodes morphologically. Second stage juveniles are translucent white, vermiform (worm-shaped), and tapered at both ends. They have a long, narrow tail and a delicate stylet (Figure 1). Females are white, pear-shaped with prominent necks variable in size (Figure 2). Males are translucent white, vermiform, and rounded at both ends (Figure 3). They are larger than juveniles with a more robust stylet and head framework. Morphological characteristics used to differentiate *Meloidogyne enterolobii* from other *Meloidogyne* species include the female perineal pattern (oval shape, coarse or smooth striae, moderately high to high arch, anus and vulva size and position) as well as the morphology of the head, tail, and stylet in various life stages (Yang and Eisenback, 1983). Identification based on molecular techniques can also be done and is often preferred as this requires only knowledge of common molecular techniques and no morphological expertise. Differentiation of *Meloidogyne enterolobii* from other common root-knot nematode species is based on the presence/absence and/or size of the amplicons in PCR reactions (Hu et al., 2011). The UF/IFAS Nematode Assay Lab performs this diagnosis by using molecular identification tools as do other professional diagnostic laboratories.

Figure 1. Second stage juvenile of Guava root-knot nematode *Meloidogyne enterolobii* at 400x magnification.
Credit: FINDME

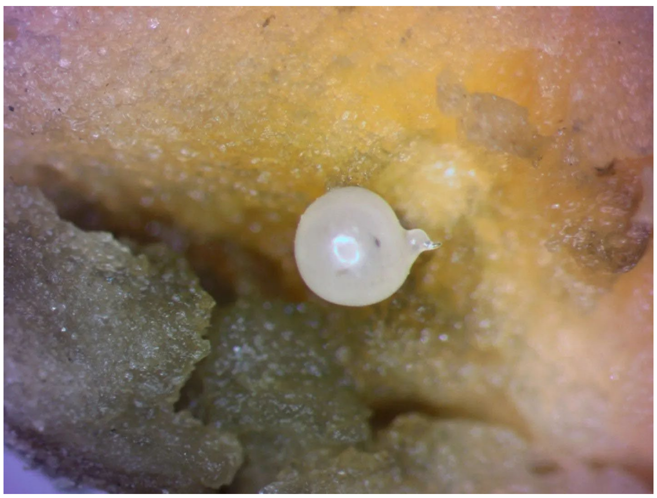

Figure 2. Guava root-knot nematode *Meloidogyne enterolobii* females are white and pear-shaped.
Credit: Will Rutter, USDA-ARS, used by permission

Figure 3. *Meloidogyne* male at 400x magnification. Males are worm-shaped with rounded heads and tails.
Credit: Zane Grabau, UF/IFAS

Life Cycle

Meloidogyne enterolobii is very similar to other root-knot nematodes in respect to life cycle. The eggs hatch into second-stage juveniles in the soil, which migrate through the soil in search of a susceptible host root. J2 stage is the only infective stage, and they invade the root tip and establish a permanent feeding site, from which the juvenile and adults feed. The root cells surrounding the feeding site enlarge and multiply, giving rise to a gall in which the juveniles are embedded. Nematodes keep developing into J3 and J4 stages, and eventually develop into globose females or vermiform males. Females produce eggs out of their body and eggs are deposited into a gelatinous matrix called “eggmass.” A single female can produce 500–1000 eggs. Mature males cease feeding and exit the roots. Males are not required for reproduction (mitotic reproduction).

Hosts

As an emerging pest, *Meloidogyne enterolobii* host tests are still ongoing, but it can infect most horticultural, ornamental, and agronomic crops based on testing thus far (Table 1).

Meloidogyne enterolobii has a similar host preference as southern root-knot nematode *Meloidogyne incognita,* except that *Meloidogyne enterolobii* can reproduce on many plant cultivars carrying *Meloidogyne* resistance genes (Table 2). Thus far, sweetpotato production in the United States, guava production in Brazil, and horticultural production in the Caribbean are the industries that have been most affected by *Meloidogyne enterolobii.* Some crop species have been reported as poor or non-hosts for *Meloidogyne enterolobii* (Table 3), including grapefruit (*Citrus paradisi*), sour orange (*Citrus aurantium*), garlic (*Allium sativum*), coconut (*Cocos nucifera*), grape (*Vitis vinifera*), mango (*Mangifera indica*), mulberry (*Morus alba*), corn (*Zea mays*), and peanut (*Arachis hypogaea*) (Rodriguez et al., 2003; European and Mediterranean Plant Protection Organization, 2014; Freitas et al., 2017; Schwarz et al., 2020). As with many other *Meloidogyne* species, the host range of *Meloidogyne enterolobii* may vary by nematode isolate, most notably for cotton (Rutter et al., 2021).

Table 1. List of common agronomic, horticultural, and ornamental crops know to be good hosts to *Meloidogyne enterolobii*.

Common name	Scientific name	Reference
Agronomic crops		
Cotton	*Gossypium hirsutum L.*	Ye et al., 2013
Soybean	*Glycine max*	Ye et al., 2013
Sweetpotato	*Ipomoea batatas*	Rutter et al., 2019
Tobacco	*Nicotiana tabacum*	Filho et al., 2016
Potato	*Solanum tuberosum*	Edward & Meleleki, 2013
Horticultural crops		
Thai basil	*Ocimum basilicum*	Gu et al., 2021
Bell pepper	*Capsicum annuum*	Assoumana et al., 2017
Cabbage	*Brassica oleracea*	Brito et al., 2007
Coffee	*Coffea*	Alves et al., 2009
Cucumber	*Cucumis sativus*	Kiewnick et al., 2008
Eggplant	*Solanum melongena*	Brito et al., 2007
Okra	*Abelmoschus esculentus*	Brito et al., 2007
Squash	*Cucurbita*	Brito et al., 2007
Tomato	*Solanum lycopersicum*	Kiewnick et al., 2008
Broccoli	*Brassica oleracea*	Brito et al., 2007
Banana	*Musa*	Silva et al., 2017
Guava	*Psidum guajava*	Gomes et al., 2008
Watermelon	*Citrullus lanatus*	Brito et al., 2007
Ornamental crops		
Angelonia	*Angelonia angustifolia*	Kaur et al., 2006
False daisy	*Eclipta prostrata*	Brito et al., 2008
Jamaican poinsettia	*Euphorbia punicea*	Han et al., 2012
Japanese blue berry	*Elaeocarpus decipiens*	Moore et al., 2020
Mulberryweed	*Fatoua villosa*	Brito et al., 2008
Poinsettia	*Poinsettia cyathophora*	Brito et al., 2008

Table 2. List of *Meloidogyne* resistance genes that *Meloidogyne enterolobii* is known to overcome. The crop listed under each resistance gene has cultivars that incorporate the given gene or quantitative trait loci.

Resistance gene(s)	Crop common name	Crop scientific name	Reference
qMi-C11, qMi-C14	cotton	*Gossypium hirsutum*	Gaudin et al., 2023
Not fully characterized	sweetpotato	*Ipomoea batatas*	Rutter et al., 2019
Mir1	soybean	*Glycine max*	Cetintas et al., 2008
Rk1	tomato	*Solanum lycopersicum*	Filho et al., 2016
N, Tabasco, Me3, Me1	pepper	*Capsicum annuum*	Brito et al., 2007; Kiewnick et al., 2009; Rutter et al., 2021
Mi1	tobacco	*Nicotiana tabacum*	Ye et al., 2013

Table 3. List of common agronomic, horticultural, and ornamental crops known to be poor or non-hosts of *Meloidogyne enterolobii*.

Common name	Scientific name	Reference
Agronomic crops		
corn	*Zea mays*	Rosa et al., 2011
peanut	*Arachis hypogaea*	Rodriguez et al., 2003
Horticultural crops		
garlic	*Allium sativum*	Rodriguez et al., 2003
grape	*Vitis*	Freitas et al., 2016
strawberry	*Fragaria ananassa*	Freitas et al., 2016
sour orange	*Citrus aurantium*	Freitas et al., 2016
passion fruit	*Passiflora edulis*	Freitas et al., 2016

Symptoms

Symptoms caused by *Meloidogyne enterolobii* are similar to those caused by other root-knot nematode species, although on certain crops symptoms of *Meloidogyne enterolobii* infection are generally more severe than that of other root-knot nematode species. The typical symptom is severe galling (knotty root growths stimulated by *Meloidogyne* infection) of the root system (Figures 4 and 5). *Meloidogyne enterolobii* also infects tubers and storage roots, such as potatoes and sweetpotatoes (Figure 6). Infected tubers can be severely deformed with large galls on the tuber, the tuber can be cracked and dark on the surface, and white round females can be discovered under the tuber surface upon inspection with a dissecting scope. In less severe or early infection, damage may appear as small bumps or lesions. Aboveground symptoms include reduced stand, chlorosis (yellowing of plant foliage), stunting and loss of vigor (Figure 7). Damage symptoms on cultivars resistant to common *Meloidogyne* species are an indication that *Meloidogyne enterolobii* may be responsible for the damage as it can infect many resistant cultivars. As with other plant-parasitic nematodes, *Meloidogyne enterolobii* symptoms typically have a patchy field distribution (Figures 8 and 9) corresponding to varying nematode populations and environmental conditions.

Figure 4. Root galling induced by *Meloidogyne enterolobii* on a pepper carrying the *N* gene for resistance to most *Meloidogyne* species.
Credit: Zane Grabau, UF/IFAS

Figure 5. Severe root galling induced by *Meloidogyne enterolobii* on tomato.
Credit: David Moreira Calix, UF/IFAS

Figure 6. *Meloidogyne enterolobii* infected sweetpotato with extensive galling and deep cracks.
Credit: Charles Overstreet, LSU, used with permission

Figure 7. *Meloidogyne* infected tomato exhibiting yellowing, stunting, and wilting.
Credit: Chang Liu, UF/IFAS

Figure 8. Patchy distribution of *Meloidogyne* symptoms (reduced stand, stunting of foliar) in a napa cabbage field.
Credit: Zane Grabau, UF/IFAS

Figure 9. Reduced stand and stunting caused by *Meloidogyne enterolobii* in pepper production.
Credit: Johan Desaeger, UF/IFAS

Management

Management of *Meloidogyne enterolobii* relies largely on techniques that have been successful with other root-knot nematodes as relatively limited field research has been done with *Meloidogyne enterolobii*. Management options also vary by crop, particularly for chemical control. See Ask IFAS nematode management guides for information on specific crops including sweetpotato, potato, cucurbits, tomatoes/peppers/eggplant, cotton, and soybean among others.

Cultural

Extreme plant quarantine methods have been implemented to restrict dispersal of *Meloidogyne enterolobii* within the United States. After this pest was found in the North Carolina sweetpotato growing belt in 2013, a number of states issued internal or external quarantines. These quarantines required planting material to be certified free of *Meloidogyne enterolobii* or restricted distribution of sweetpotato produced from states confirmed to have this pest. Quarantine is a critical step in preventing this species spreading in a certain area. Using qualified nematode-free seedlings and planting in clean fields even in areas where quarantines are not in place are important measures as they will prevent introduction of *Meloidogyne enterolobii* into the field.

Biological

Once *Meloidogyne enterolobii* is established in fields, it is generally not feasible to eradicate this pest and management relies on limiting the abundances of the nematode to alleviate crop damage. Crop rotation with poor- or non-hosts is a common and very successful method for managing other *Meloidogyne* species. The limited number of poor- or non-hosts for *Meloidogyne enterolobii*, particularly among high value crops, is the main factor that limits use of this practice. Biological control using fungal or bacterial agents may also be a useful tool for integrated pest management of *Meloidogyne enterolobii*. The fungus *Trichoderma harzianum* has shown value for managing *Meloidogyne enterolobii* on guava (Jindapunnapat et al, 2013), and the fungi *Pochonia chlamydosporia* and *Purpureocillium lilacinum* have had some efficacy in laboratory tests (Silva et al., 2017). Due to its ability to infect most known *Meloidogyne* resistant cultivars, use of resistant cultivars is currently unavailable to growers for managing this pest.

Chemical

There are both fumigant and non-fumigant nematicides registered for root-knot nematode management in Florida (Grabau, 2024). However, vegetables and ornamentals still largely rely on fumigation. Nematicides should be effective against *Meloidogyne enterolobii*, but more research on chemical control of this emerging pest is needed.

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Selected References

Alves GCS, de Almeida EJ, dos Santos JM. 2009. Reaction of *Coffea* spp. to *Meloidogyne mayaguensis*. Nematologia Brasileira 33: 248–251.

Assoumana BT, Habash S, Ndiaye M, Van der Puije J, Sarr E, Adamou H, Grundler FMW, Elashry A. 2017. First report of the root-knot nematode *Meloidogyne enterolobii* parasitising sweet pepper (*Capsicum annuum*) in Niger. New Disease Reports 36: 18.

Baojun Y, Eisenback JD. 1983. *Meloidogyne enterolobii* n. sp. (*Meloidogynidae*), a root-knot nematode parasitizing pacara ear pod tree in China. Journal of Nematology 15(3): 381–391.

Brito JA, Powers TO, Mullin G, Inserra, RN, Dickson DW. 2004. Morphological and molecular characterization of *Meloidogyne mayaguensis* from Florida. Journal of Nematology 36(3): 232– 240.

Brito JA, Kaur R, Cetintas R, Stanley JD, Mendes M, McAvoy EJ, Powers TO, Dickson DW. 2008. Identification and isozyme characterisation of *Meloidogyne* spp. infecting horticultural and agronomic crops and weed plants in Florida. Nematology 10(5): 757–766.

Brito JA, Kaur R, Cetintas R, Stanley JD, Mendes ML, Powers TO, Dickson DW. 2010. *Meloidogyne* spp. infecting ornamental plants in Florida. Nematropica 40(1): 87–104.

Brito JA, Smith T, Dickson DW. 2015. First report of *Meloidogyne enterolobii* infecting *Artocarpus heterophyllus* worldwide. Disease Notes 99(9): 1284–1285.

Brito JA, Desaeger J, Dickson DW. 2020. Reproduction of *Meloidogyne enterolobii* on selected root-knot nematode resistant sweetpotato (*Ipomoea batatas*) cultivars. Journal of Nematology. 52:1–6.

Castagnone-Sereno P. 2012. *Meloidognye enterolobii* (= *M. mayaguensis*): profile of an emerging, highly pathogenic root-knot nematode species. Nematology 14(2): 133–138.

Castillo P, Castagnone-Sereno P. 2020. *Meloidogyne enterolobii* (Pacara earpod tree root-knot nematode). Invasive Species Compendium. Wallingford, UK: CABI.

Edward OM, Moleleki L. 2013. Detection of *Meloidogyne enterolobii* in potatoes in South Africa and phylogenetic analysis based on intergenic region and the mitochondrial DNA sequences. European Journal of Plant Pathology 136(1): 1–5.

Filho JVA, Machado JV, Dallagnol ACZ, Camargo LEA. 2016. Root-knot Nematodes (*Meloidogyne* spp.) parasitizing resistant tobacco cultivars in southern Brazil. Plant Disease 100(6): 1222–1231.

Freitas VM, Silva JP, Gomes C, Castro JC, Correa V, Carneiro RDG. 2016. Host status of selected cultivated fruit crops to *Meloidogyne enterolobii*. European Journal of Plant Pathology 148(2): 307–319.

Grabau ZJ. 2024. Fumigant and nonfumigant nematicides labeled for agronomic crops in Florida. ENY-065. *EDIS* 2024.

Gomes CB, Couto MEO, Carneiro RMDG. 2008. Occurrence of *Meloidogyne mayaguensis* on guava and tabaco in south of Brazil. Nematologia Brasileira 32: 244–247.

Gu M, Bui HX, Ye W, and Desaeger J. 2021. The first report of *Meloidogyne enterolobii* on Thai basil in Florida, United States. Plant Disease 105(11): 3764.

Han H, Brito JA, Dickson DW. 2012. First report of *Meloidogyne enterolobii* infecting *Euphorbia punicea* in Florida. Plant Disease 96(11): 1706.

Hu MX, Zhuo K, Liao JL. 2011. Multiplex PCR for the simultaneous identification and detection of *Meloidogyne incognita*, *M. enterolobii*, and *M. javanica* using DNA extracted directly from individual galls. Phytopathology 101(11): 1270–1277.

Jindapunnapat K, Chinnasri B, Kwankuae S. 2013. Biological control of root-knot nematodes (*Meloidogyne enterolobii*) in guava by the fungus *Trichoderma harzianum*. Journal of Developments in Sustainable Agriculture 8(2): 110–118.

Kaur R, Brito JA, Dickson DW. 2006. First Report of *Meloidogyne mayaguensis* on *Angelonia angustifolia*. Plant Disease 90(8): 1113.

Kiewnick S, Karssen G, Brito JA, Oggenfuss M, Frey JE. 2008. First report of root-knot nematode *Meloidogyne enterolobii* on tomato and cucumber in Switzerland. Disease Notes 92(9): 1370.

Kiewnick S. 2009. Effects of the *Mi-1* and the *N* root-knot nematode-resistance gene on infection and reproduction of *Meloidogyne enterolobii* on tomato and pepper cultivars. Journal of Nematology 41(2): 134–139.

Moore MR, Brito JA, Qiu S, Roberts CG. 2020. First report of *Meloidogyne enterolobii* infecting Japanese blue berry tree (*Elaeocarpus decipiens*) in Florida, USA. Journal of Nematology 52: e2020–05.

Overstreet C, McGawley EC, Clark C, Rezende J, Smith T, Sistrunk M. 2018. Guava root-knot nematode a potentially serious new pest in Louisiana. Pub 3670. Baton Rouge: Louisiana State University AgCenter.

Rammah A, Hirschmann H. 1988. *Meloidogyne mayaguensis* n. sp. (*Meloidogynidae*), a root-knot nematode from Puerto Rico. Journal of Nematology 20(1): 58–69.

Rodriguez M, Sanchez L, Rowe J. 2003. Host status of agriculturally important plant families to the root-knot nematode *Meloidogyne mayaguensis* in Cuba. 2003. Nematropica 33(2): 125–130.

Rosa JMO, Westerich JN, Wilcken SRS. 2011. Reaction of maize hybrids and cultivars to *Meloidogyne enterolobii* and *M. javanica*. Nematologia Brasileira 36(1): 9–14.

Rutter WB, Skantar AM, Handoo ZA, Mueller JD, Aultman SP, Agudelo P. 2019. *Meloidogyne enterolobii* found infecting root-knot nematode resistant sweetpotato in South Carolina, United States. Plant disease 103(4): 775.

Schwarz T, Li C, Ye W, Davis E. 2020. Distribution of *Meloidogyne enterolobii* in eastern North Carolina and comparison of four isolates. Plant Health Progress 21(2): 91–96.

Silva S, Carneiro RMDG, Faria M, Souza DA, Monnerat RG, Lopez RB. 2017. Evaluation of *Pochonia chlamydosporia* and *Purpureocillium lilacinum* for suppression of *Meloidogyne enterolobii* on tomato and banana. Journal of Nematology 49(1): 77–85.

Ye W, Koenning SR, Zhuo K, Liao J. 2013. First report of *Meloidogyne enterolobii* on cotton and soybean in North Carolina, USA. Plant Disease 97(9): 1262.

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