

Nematode Management in Sweet Potatoes (including Boniatos)¹

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The primary intended audience is agricultural professionals involved in commercial sweet potato production directly or through advising roles (Extension agents, producers, crop consultants, academics, etc.). The purpose is to guide professionals in improving nematode management in sweet potato production. Similar to other EDIS nematode management guides, it is intended to give a concise but relatively comprehensive summary of relevant information to understand and manage nematodes in this crop in Florida.

Sweet Potato Production in Florida

Florida is an important sweet potato (*Ipomoea batatas*) producer with 812 million pounds produced in 2018, ranking sixth in the United States (USDA 2020). Production includes both conventional and Boniato type sweet potatoes. Conventional sweet potatoes have high sugar content, typically with orange flesh. Boniato sweet potatoes have white flesh that is drier with more starch and less sugar. Boniatos are common in south Florida, in part because they are popular in Cuban cuisine prevalent in that area. In Florida, most conventional sweet potatoes are grown in the north-central region with some production emerging in northeast Florida. Crop-nematode interactions and nematode management are similar for both types of sweet potato except where noted. For further information on sweet potato production in Florida, see the latest root

crop production chapter in the [UF/IFAS Vegetable Production Handbook](#) (Dittmar et al. 2020).

Plant-Parasitic Nematodes

Plant-parasitic nematodes are microscopic roundworms that feed on plant tissue. Most plant-parasitic nematodes live in the soil and attack the roots of plants. This can reduce yield by reducing plant growth and disfiguring sweet potato storage roots (the fleshy, tuberous roots that are the marketable product), which reduces or eliminates marketable value. Southern root-knot nematode (*Meloidogyne incognita*) is the most common and important nematode pest of sweet potato (*Ipomoea batatas*) in the Southeast, and likely Florida. Javanese root-knot nematode (*Meloidogyne javanica*) is also common in Florida and can damage sweet potato. The invasive guava root-knot nematode (*Meloidogyne enterolobii*)—concerning for its ability to overcome nematode-resistant sweet potato cultivars—is also present in Florida, but its prevalence in Florida sweet potato production is unknown. The reniform nematode (*Rotylenchulus reniformis*) can also be damaging to sweet potato, but in Florida is limited primarily to the Panhandle and far south. This is due to its preference for heavier soils and proliferation on cotton, a crop common in the Florida Panhandle. Sting nematode (*Belonolaimus longicaudatus*) is damaging to a wide range of crops and is prevalent in northeast Florida where sweet potato production is

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increasing. Preliminary observations suggest sting nematode can be damaging to sweet potato, but the relationship is still being investigated. For more information about these nematodes, see the following publications on [sting nematode](#) (Crow 2018) and [reniform nematode](#) (Wang 2019). Several other nematodes are associated with sweet potato, but their impact on yield in Florida is either low or unknown.

Plant-parasitic nematodes can be grouped based on their feeding habits, and this can be an important factor in diagnostics and management. Nematode life stages include the egg, four pre-adult juvenile stages, and a mature adult stage. All plant-parasitic nematodes have a stylet, which is a needle-like mouthpart that is typically hollow and used to draw nutrients from the host plant. Migratory ectoparasites (Figure 1) are mobile (migratory), and only their stylet enters the root while feeding; the rest of the body remains outside (ectoparasite). These nematodes move from one root feeding site to another. Sting nematodes are migratory ectoparasites. Migratory endoparasites are mobile and move from site to site when feeding, but fully enter the root to feed. Lesion nematode (*Pratylenchus* spp.) is an example of a migratory endoparasite (Figure 2). Sedentary endoparasites enter the root to feed, induce the plant to form a complex feeding site, and do not move from this site once established as a juvenile or adult female (Figure 3). The female stage of sedentary endoparasites becomes enlarged as it feeds and produces hundreds of eggs. Root-knot and reniform nematodes are sedentary endoparasites.

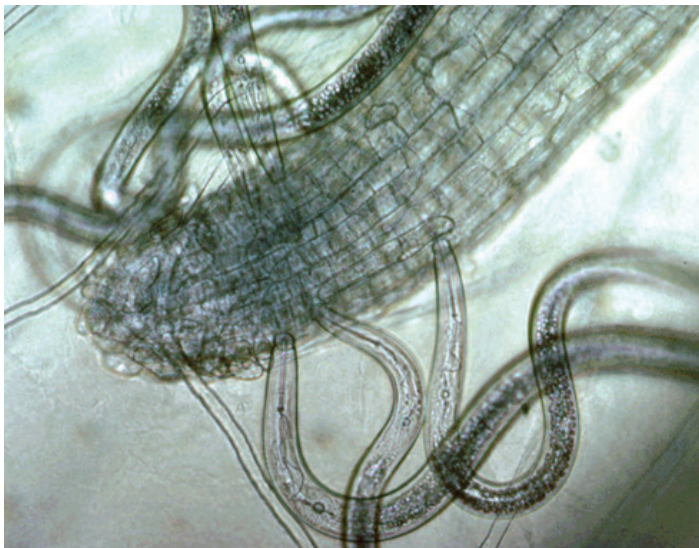


Figure 1. Migratory ectoparasites (sting nematode pictured here) insert their stylets to feed, leaving their bodies outside the root. Credits: Ole Becker, University of California Riverside. Used with permission.



Figure 2. Migratory endoparasites feed with their bodies inside the root and move from site to site in the root to feed. Generally, all life stages are of a relatively similar size. Credits: A.C. Hixson, UF/IFAS

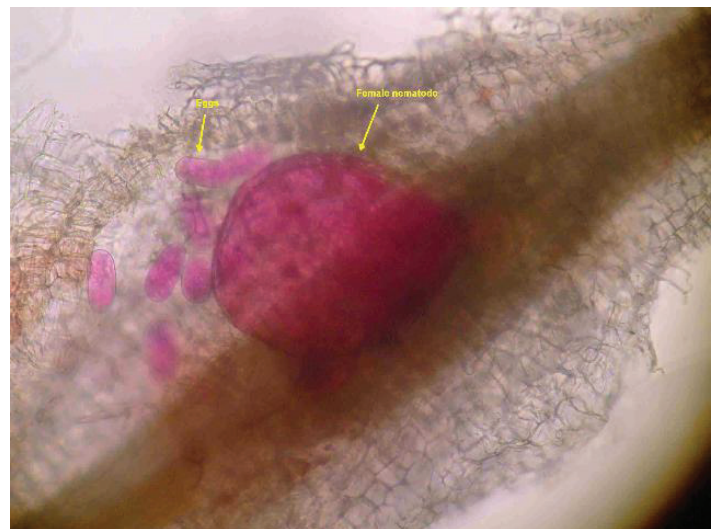


Figure 3. Sedentary endoparasites (root-knot nematode pictured here) establish a complex feeding site in the root as a juvenile or immature female and do not move from that site for the rest of their lives. Adult females enlarge as they feed and produce eggs. Credits: N.S. Sekora, UF/IFAS

Symptoms and Damage

Monitor for symptoms to spot potential nematode problems. Subsequent confirmation by sampling, as described in the next section, is generally necessary. Additionally, yield loss from nematodes can occur in the absence of obvious symptoms, so routine sampling is an important complement to scouting for symptoms. Foliar symptoms of nematode infestation generally involve stunting, wilting, leaf chlorosis (yellowing), and other symptoms indicating nutrient deficiency (Figures 4 and 5). Nematode-infested fields may have poor vine canopy coverage (Figures 6 and 7) due to delayed or reduced vine growth. In severe cases, plant parts may die and turn brown (necrosis), or entire

plants may die, resulting in reduced stand. Plants exhibiting stunt or decline symptoms usually occur in patches of non-uniform growth (Figure 8) rather than evenly throughout a field and correspond to varying nematode abundances and environmental conditions (soil type, moisture, fertility).



Figure 4. Patchy leaf chlorosis (bottom left) and generalized wilting in a field trial with severe root-knot nematode infestation.
Credits: Zane Grabau, UF/IFAS



Figure 5. Severe leaf chlorosis (yellowing) and other discoloring late in the season in a field with severe southern root-knot nematode infestation.
Credits: Zane Grabau, UF/IFAS



Figure 6. Poor vine coverage and vigor late in the season in a trial with severe southern root-knot nematode infestation and poor soil fertility.
Credits: Zane Grabau, UF/IFAS

Belowground symptoms caused by nematodes may show up on storage roots or fibrous roots—any smaller root not swollen into a storage root. Galling—irregular swelling of fibrous roots (Figures 9 and 10) or storage roots (Figure 11)—is a diagnostic characteristic of root-knot nematode infection. On fibrous roots, gall size may range from a few small, spherical swellings to large, tumorous swellings (Figure 12). Similarly, galling on storage roots may range

from small dimples to big, mottled bumps (Figure 11). Galling and other symptoms are often more severe when initial nematode soil infestation is greater, when samples are taken later in the year as damage accumulates, when more susceptible cultivars are grown, and when environmental conditions (drought, disease, extreme heat, etc.) stress the plants. In severe cases, infected tubers may have decayed regions (Figure 14) and be more susceptible to secondary infection by diseases. Storage root cracking may also occur, although this is infrequent in modern cultivars when common root-knot nematodes are present. Other factors, such as environmental stress or reniform nematode infestation can also induce growth cracks. Belowground symptoms tend to be more severe when the guava root-knot nematode is present. Galling can be more prolific, and storage root cracking (Figure 15) tends to be more common with this nematode. Widespread and prolific symptoms on a resistant cultivar are further indicators that guava root-knot nematode may be present. Diagnosis by a professional nematology lab, as described in the section below, is needed to determine which root-knot nematode species (guava, southern, or another root-knot nematode) is present.



Figure 7. Reduced vine growth (left) due to severe reniform nematode pressure in a research trial. The more vigorous plot on the right is fumigated, so it has less reniform nematode pressure.
Credits: Christopher Clark, LSU; used by permission



Figure 8. Plant stunting caused by root-knot nematode (*Meloidogyne* spp.) in Napa cabbage. Symptoms have an irregular, patchy field distribution characteristic of biological disease agents, such as nematodes.
Credits: Zane Grabau, UF/IFAS

Symptoms of reniform nematode infestation are often generalized and difficult to detect. Reniform nematode infestation causes general stunting of the root system and delayed development (Figure 16). Reniform nematode infestation can induce storage root cracking. While this symptom is infrequent, cracks tend to develop early and result in deep fissures by the end of the year (Figure 17). Sting nematode can be very injurious to many crops, causing infected plants to form a tight mat of short roots that are often swollen at the tips (Figure 18). New root ends are often killed by heavy infestations, leaving pruned, necrotic (brown and dying) root tips (Figure 19).



Figure 12. Severe galling (irregularly shaped swellings) of young sweet potato fibrous roots due to root-knot nematode infestation.
Credits: Zane Grabau, UF/IFAS



Figure 13. Darker regions of decay and secondary infection along with galling as a result of severe southern root-knot nematode infection.
Credits: Zane Grabau, UF/IFAS



Figure 14. Galling of various sizes—ranging from small dimples to extensive swelling—on young storage roots induced from southern root-knot nematode infestation. The storage root on the right also has a small growth crack, which is an infrequent symptom of common root-knot nematodes.
Credits: Zane Grabau, UF/IFAS



Figure 15. Severe galling and growth cracks on sweet potato storage roots due to the guava root-knot nematode. Galling tends to be more prolific and storage root cracking more common with this nematode than with common root-knot nematodes.
Credits: Charles Overstreet, LSU; used by permission



Figure 9. Extensive galling (roughly circular swellings) from southern root-knot nematode on fibrous roots and developing storage roots at midseason.
Credits: Zane Grabau, UF/IFAS



Figure 10. Severe galling from root-knot nematodes on fibrous roots emerging from young sweet potato slip (right) compared with a healthier plant (left) with a more robust, branched root system.
Credits: Zane Grabau, UF/IFAS



Figure 11. Extensive galling and disfiguration from southern root-knot nematode on a susceptible sweet potato storage root.
Credits: Zane Grabau, UF/IFAS

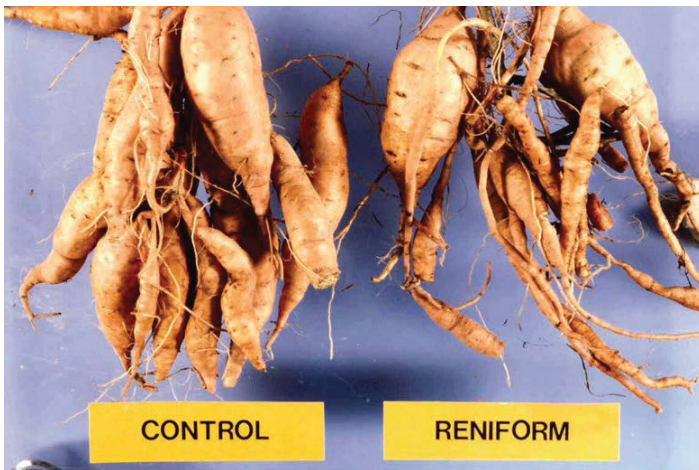


Figure 16. Stunting, delayed development, and decreased storage root production in reniform-infested sweet potato (right) compared with uninfested.

Credits: Charles Overstreet, LSU; used by permission



Figure 17. Deep growth cracks on storage root induced by reniform nematode infestation. Growth cracks are an infrequent symptom of reniform nematode infestation, but they tend to be induced early in the year, resulting in very deep fissures by the end of the year.

Credits: Christopher Clark, LSU; used by permission



Figure 18. Severe sting nematode infestation in white potato impairs root function, leading to reduced growth (right plant) compared to growth in healthy plants (left plant). The infested plant has a stunted root system with fewer lateral roots.

Credits: Zane Grabau, UF/IFAS

Both reniform and root-knot nematodes are highly damaging to sweet potato, even at low populations, and warrant management any time they are detected. Sting nematode is similarly damaging on most crops, although its interaction with sweet potato is still being determined. The extent of yield loss will vary based on factors such as nematode population density, crop susceptibility, and prevailing environmental conditions. These factors will also affect the

timing and severity of damage symptoms, which should be considered when scouting. The greater the nematode abundance, the earlier and more severe the symptoms. Similarly, a very susceptible cultivar (vulnerable to damage by a particular nematode) will sustain more yield loss and may have earlier and more severe symptoms. Environmental stress (drought, high temperatures, low fertility, other diseases, etc.) exacerbates damage.



Figure 19. Symptoms of sting nematode damage on white potato roots. The affected root system is stunted, with fewer lateral roots. Lateral roots are pruned, necrotic (browning), and proliferate near the growing tuber, creating a bearded appearance.

Credits: Zane Grabau, UF/IFAS

Field Diagnosis and Sampling

Soil/tissue sampling and submission to a professional nematode diagnostic lab such as the [UF/IFAS Nematode Assay Laboratory](#) is usually required to confirm nematode problems. Nematode sampling is either (1) predictive: determining risk of nematode damage before planting a given crop, or (2) diagnostic: determining if disease symptoms in a crop are caused by nematodes. Predictive samples must be taken before the crop is planted because current nematode management tactics must be deployed at or before planting. Similarly, diagnostic samples are useful for planning management for subsequent crops, but are generally too late to rescue the current crop. Proper collection and submission of samples using the following steps is key for successful nematode diagnosis, and full instructions can be found on the [UF/IFAS Nematode Assay Laboratory](#) website. Some key points are summarized here:

1. Always include a soil sample when assessing nematodes because some nematodes (ectoparasites) can only be detected in soil and not roots. Supplement with root samples if possible. Pictures of root and foliar symptoms are also useful.
2. For predictive samples, sampling just before harvest of the previous crop is best because nematode abundances are greatest at that time. Take diagnostic samples when symptoms appear.

3. Collect samples from 10 to 20 field points from an area of less than 5 acres (predictive) or in the area of symptomatic, but not dead, plants (diagnostic).
4. Sample soil from the rooting zone (within a few inches of stems to at least 8 inches deep) where nematode abundances are greatest.
5. After collection, avoid overheating, drying, and mechanical damage—handle bags gently and avoid tossing or crushing them. Samples can be stored for a few hours at room temperature, but keep them out of sun and extreme heat. Using closed plastic bags helps with moisture retention if the bags are stored properly. If storing bags overnight, refrigerate them.
6. Long delivery may subject samples to extreme temperatures. Avoid weekend shipping and use the fastest feasible delivery method.
7. Root samples should be collected in a similar manner, except that fewer point samples (2–5) are realistic. Roots may rot in excess moisture, so do not surround samples with moist material. Send roots surrounded with some soil—provides moderate moisture—or bare.

For each routine sample submitted, the UF/IFAS Nematode Assay Lab will provide a report of the genera (root-knot nematode, reniform nematode, etc.) and quantity of plant-parasitic nematodes in each sample, as well as an assessment of damage risk and management recommendations. Further testing is required to determine the particular species of root-knot nematode in a field (guava root-knot nematode, southern root-knot nematode, etc.), which may influence cultivar selection. The UF/IFAS Nematode Assay Lab can conduct these tests, and they are easiest to complete when root-knot nematode-infected root material is provided. Contact your local Extension agent or Z. J. Grabau for assistance with nematode sampling or for a field consultation.

Nematode Management

Nematode management strategies rely on reducing nematode abundances to reduce crop damage or choosing a resistant cultivar that avoids most or all damage from a particular nematode. The primary nematode management strategies include (1) use of resistant or tolerant cultivars, (2) crop rotation and other cultural practices, (3) nematicide application, and (4) biological control. When possible, multiple management strategies should be integrated as part of a systems approach.

Cultivar and Transplant Selection

Use nematode-free transplants to avoid compromising production. Planting slips (cut plant stems) free of roots or soil is the best way to ensure transplants are not infested with nematodes. Avoid planting storage root pieces or slips with roots or soil as they may contain nematodes. If material with soil or roots is used, ensure these materials are grown in sterilized medium or field soil that is properly managed for nematodes, ideally with a fumigant.

Cultivars with resistance to southern root-knot nematode are available (Table 1). These cultivars both slow southern root-knot nematode reproduction and reduce damage from that nematode (Figure 20). The level of resistance varies by cultivar, with the most common cultivar in Florida, Covington, only offering moderate resistance. Some nematode reproduction and yield loss still occurs on moderately resistant cultivars, so additional crop rotation or nematicide application is generally needed for sufficient management (Johnson et al. 1992). Boniato cultivars commonly grown in Florida are not resistant, but two resistant Boniato cultivars (Liberty and Bonita) are available (Jackson et al. 2011). None of the resistant cultivars are effective against guava root-knot nematode (Brito et al. 2020). Beauregard is susceptible while Jewel and Hernandez are resistant to Javanese root-knot nematode (Cervantes-Flores 2002), but reaction to this nematode is not reported for most cultivars. Many cultivars are not susceptible to peanut root-knot nematode (Cervantes-Flores 2002), which suggests that this common root-knot nematode may not be a common problem for sweet potato. Resistance to any other nematodes has not been identified in commercial sweet potato cultivars.



Figure 20. A cultivar (Covington) resistant to southern root-knot nematode free of galling (left) compared with a susceptible variety (Orleans) with wart-like galls from southern root-knot nematode on developing storage roots (right).

Credits: Zane Grabau, UF/IFAS

Crop Rotation

Rotating poor or non-host crops with susceptible cash or cover crops is an important practice for nematode management. A poor or non-host supports little or no reproduction of a particular nematode, so nematode populations decrease, reducing damage to subsequent susceptible crops. Susceptibility varies based on the particular nematode-crop combination, so an ideal rotation will vary based on the species of nematode(s) in a particular field (Table 2). Certain crops—such as sunn hemp—also produce allelochemicals that may actively reduce nematode populations. Nematodes may still feed on crops that produce allelochemicals, so host status is important to consider. The amount of time a field needs to be rotated to a nonhost crop to reduce nematode populations below a damaging level will vary based on many factors including initial nematode populations, environmental conditions, and other nematode management practices used. If implemented alone, multiple seasons of a nonhost crop are often needed to reduce nematode populations below a damaging level. For more information on cover crops, see these publications on [Florida cover crop production](#) (Wright et al. 2017) and [cover crops for root-knot nematode](#) (Gill and McSorley 2017). Also see [nematode management using sunn hemp](#) (Wang and McSorley 2018a), [cowpea](#) (Wang and McSorley 2018b), and [sorghum-sudangrass](#) (Dover et al. 2018).

Other Cultural Practices

Proper weed management is an important component of nematode management because weeds can serve as hosts for plant-parasitic nematodes and increase or maintain populations during fallow or when a nonhost crop is grown. For example, nutsedge, pigweed, and lambsquarters, among many others, are generally good hosts of root-knot nematodes. Additionally, crops should be terminated by herbicide application or tillage as soon as possible after a crop is harvested. If crops are left in the field after harvest, nematodes can continue to reproduce on their roots. Tillage may contribute to reducing nematode abundances because it heats, dries, and mechanically disturbs the soil as well as destroying potential host plants. Finally, any practices that promote plant health, such as proper irrigation, maintenance of soil fertility, and management of other diseases, may increase plant tolerance to nematodes.

Chemical Control

Most fields in Florida should be treated with nematicides to improve sweet potato production. Nematicide application reduces nematode populations temporarily, reducing nematode infection and crop damage. When a susceptible

crop is grown after nematicide application, nematode populations will eventually begin to increase again. For this reason, nematicide application generally must be repeated before each season a susceptible crop is grown.

FUMIGANT NEMATICIDES

Fumigants are pesticides that move through the soil as gases (Table 3). Typically, the best-performing fumigants are the most effective chemical option for nematode management in Florida. Many fumigants are broad-spectrum—they may have activity against nematodes, fungal or bacterial pathogens, and weeds. Current fumigants do not provide consistently excellent control of all of these pests (Table 4), so combinations of chemistries or management strategies are often needed for pest management. Fumigants move through the soil relatively quickly—a matter of hours or days—and must contact nematodes to kill them. Therefore, successful fumigation relies on sufficient coverage of a broad swath of soil. Because of this, soil conditions and application techniques affect fumigant performance. Most of these practices are now regulated through EPA Good Agricultural Practices and specified on fumigant labels. In brief, environmental conditions such as soil moisture, temperature, and plant residue affect fumigation. Mechanical factors such as fumigation depth, spacing, and soil sealing are also critical. Allow proper setback time between fumigation and planting—as specified on product labels—in order to avoid crop injury from fumigant residues.

NON-FUMIGANT NEMATICIDES

Non-fumigant nematicides are liquid or granular products that move through the soil in water. Various non-fumigant nematicides are currently registered for use in sweet potato and can be applied by various means intended to incorporate the nematicides into the rooting zone of the soil (Table 5). Non-fumigant nematicides generally provide a more narrow spectrum of activity than fumigants, primarily targeting nematodes, although certain products also may have efficacy against certain insects (Majestene, Mocap 15G and Vydate L) or certain fungal pathogens (Velum). Efficacy of non-fumigants varies by product, but non-fumigants are generally less effective than fumigants for control of most nematodes (Table 5). Non-fumigant nematicides work by coming into contact with nematodes in the soil, or, if the product has systemic activity, by being taken up by the plant (Table 6). Therefore, the ability of a product to dissolve and move in water (solubility) and the length of time it takes for the compound to break down (persistence) greatly influence the efficacy of non-fumigants. Mobile non-fumigants (Mocap, Vydate L, and Nimitz) are likely to come in contact with nematodes in the soil more quickly

than poorly mobile non-fumigants. Very mobile products (particularly Vydate L) also move out of the rooting zone more quickly, particularly with excess rainfall, which can reduce efficacy. A highly persistent nematicide (Velum) will stay in the soil longer, increasing exposure to nematodes. Human toxicity of these products, and thus required handler precautions, also vary by nematicide.

In addition to product characteristics, application methods and soil conditions will greatly influence nematicide efficacy. Always refer to the latest label instructions for proper application procedures. In general, non-fumigants are most effective when they are uniformly applied to soil and targeted toward the future rooting zone of the plant, where they will contact nematodes or be absorbed by the plant. Non-fumigant materials work best in moist soils. Proper tillage—particularly for more immobile products—and irrigation are also critical in order to thoroughly mix non-fumigants into the soil where crops will be grown.

Biological Control

Biological control uses living organisms to manage pests. Biological control organisms used against nematodes either produce chemicals detrimental to nematodes or directly parasitize nematodes. One method of biological control is an inundative approach where biological control organisms are introduced to the field, generally as a commercial product. MeloCon WG is a biological control product listed in Tables 5 and 6 as it is a formulation of live *Purpureocillium lilacinum* fungi. Efficacy depends not only on proper distribution in the soil but conditions (such as soil moisture) being conducive for the live organisms. A second approach to biological control is making use of biological control organisms that are native to soil. Many biological control organisms are known to reside in soil, and there are field locations suppressive to nematodes (nematode populations maintained lower than expected despite susceptible crop). Factors such as avoiding broad-spectrum pesticides, avoiding tillage, increasing organic matter input (cover crops or amendments), and increasing crop monoculture may stimulate inherent biological control. However, work is ongoing to channel natural biological control processes into consistent nematode management.

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Table 1. Susceptibility of cultivars to southern root-knot nematode as sorted by type.¹

Sweet Potato Cultivar	Resistance to Southern Root-Knot Nematode	Skin Color	Flesh Color
Conventional Orange-fleshed Cultivars			
Beauregard ²	Susceptible ³	Copper	Orange
Orleans	Susceptible	Light rose	Orange
Covington ²	Moderately resistant	Light rose	Orange
Jewel	Moderately resistant ³	Light orange	Orange
Bellevue	Highly resistant	Copper	Orange
Hernandez ²	Highly resistant ³	Orange	Orange
Specialty Cultivars			
Violet Queen ²	Unknown	Purple	Purple
Georgia Red	Moderately resistant	Red	Orange
Evangeline ²	Moderately resistant	Dark rose	Orange
Charleston scarlet	Resistant	Red	Orange
Murasaki-29	Highly resistant	White	Purple
Burgundy	Highly resistant	Red	Orange
Boniato (dry) Cultivars			
Campeon ²	Unknown	Light red	White
Homestead	Unknown	Cream	White
New Boniato ²	Unknown	Cream	White
Picadito ²	Susceptible	Dark red	White
Liberty	Resistant	Red	Cream
Bonita	Highly resistant	Cream	White

¹ Resistance determinations are based on observations and literature including: (Brito et al. 2020; Cervantes-Flores et al. 2002; Jackson et al. 2011; LaBonte et al. 2008; Smith et al. 2017; Yencho et al. 2008).

² Cultivars reported to be commonly grown in certain regions in Florida.

³ Beauregard is susceptible while Jewel and Hernandez are resistant to Javanese root-knot nematode. Other cultivars have not been tested.

Table 2. Host status of common cash and summer cover crops for plant-parasitic nematodes important for Florida sweet potato production.¹

	Southern Root-Knot Nematode	Javanese Root-Knot Nematode	Guava Root-Knot Nematode	Sting Nematode
Cash Crops				
Cabbage	Host	Varies	Host	Host
Corn	Host	Host	Poor host	Host
Cotton	Host	Poor host	Host	Host
Peanut	Poor host	Host	Poor host	Varies
Potato	Host	Host	Host	Host
Soybean	Host ²	Host	Host	Host
Tomato	Host ²	Host ²	Host	Host
Watermelon	Host	Host	Host	Unknown ³
Summer Cover Crops				
Sorghum-sudangrass	Poor host	Poor host	Poor host	Host
Sunn hemp	Poor host	Poor host	Poor host	Poor host
Cowpea	Host ²	Host ²	Host	Host
Hairy indigo	Poor host	Poor host	Unknown	Poor host
Jointvetch	Poor host	Poor host	Unknown	Unknown
Winter Cover Crops				
Oats	Poor host	Poor host	Poor host	Host
Rye	Poor host	Poor host	Poor host	Host
Wheat	Varies	Poor host	Poor host	Host

Host= good host which will increase populations; Poor host= poor/non-host which will decrease populations; Varies= susceptibility varies by cultivar or report (may suggest an intermediate level of susceptibility). Within species, different nematode races/populations may exist and relationships may differ for specific nematode populations and crop cultivars.

¹ Information is based on observations and literature at the time of publication (Rodriguez-Kabana et al. 1990; Rodriguez-Kabana et al. 1992; Crow et al. 2001; Gill and McSorley 2017; Dover et al. 2018; Wang and McSorley 2018a,b).

² Resistant cultivars are available. Most cultivars are good hosts.

³ Watermelon has been observed anecdotally to be a poor host or to tolerate sting nematode, but formal research is needed.

Table 3. Fumigant nematicides for sweet potato in Florida.

Nematicide²	Broadcast Application Rates¹		In-the-Row Applications
	Gallons Per Acre	fl oz/1000 ft/ Chisel Spaced 12 in apart	
Telone II ³	9 to 12	26 to 35	May be concentrated in row. Do not exceed broadcast rate.
Telone C-17 ³	10.8 to 17.1	31.8 to 50.2	May be concentrated in row. Do not exceed broadcast rate.
Telone C-35 ³	13 to 20.5	38.2 to 60.2	May be concentrated in row. Do not exceed broadcast rate.
Pic-Clor 60	19 to 31.5	57 to 90	May be concentrated in row. Do not exceed broadcast rate.
Pic 100	150 to 350 lb	–	May be concentrated in row. Do not exceed broadcast rate.
Vapam HL	75	–	Must proportionally reduce rates and modify flow for drip or in-row chisel application. See label.
KPam HL	60	–	Must proportionally reduce rates and modify flow for drip or in-row chisel application. See label.
Dominus	40	–	Must proportionally reduce rates and modify flow for drip or in-row chisel application. See label.

¹ Rates provided only for mineral soils. Higher rates may be allowed for heavier textured (loam, silt, clay) or highly organic soils. At the time of publication, rates are believed to be correct for products named and similar products of other brand names. However, the **grower** has the final responsibility to see that each product is used legally. **Read the label** of the product to be sure that you are using it properly.

² All of the fumigants mentioned are for retail sale and use only by state-certified applicators or persons under their direct supervision. New supplemental labeling for the Telone products must be in the hands of the user at the time of application.

³ Higher application rates are allowed in the presence of cyst-forming nematodes.

Table 4. Generalized summary of maximum use rate and relative effectiveness of various soil fumigant alternatives to methyl bromide for nematode, soilborne disease, and weed control in Florida.

Fumigant Trade Name ¹	Active Ingredient	Relative Pesticidal Activity		
		Nematode	Disease	Weed
Pic 100	Chloropicrin	Poor	Excellent	Poor
Dominus	Allyl isothiocyanate	Poor to good	Poor to good	Poor to good
KPam HL	Metam potassium	Fair to good	Fair to good	Fair to good
Vapam HL	Metam-sodium	Fair to good	Fair to good	Fair to good
Telone II	1,3-Dichloropropene	Good to excellent	None to poor	Poor
Telone C17	1,3-Dichloropropene + chloropicrin	Good to excellent	Good	Poor
Telone C35	1,3-Dichloropropene + chloropicrin	Good to excellent	Good to excellent	Poor to fair
Pic-Clor 60	1,3-Dichloropropene + chloropicrin	Good to excellent	Good to excellent	Poor to fair

¹ Additional products for a given active ingredient may be available. The mention of a product or trade name does not imply endorsement to the exclusion of other products.

Table 5. Non-fumigant products for sweet potato in Florida.

Nematicide Trade Name (Active Ingredient) ¹	Labeled Rate ²	Application Timing	Application Methods
Mocap 15G (ethoprop)	20–26 lb/a (1.6–2.1 lb/1000 row-ft)	2–3 weeks before planting	Banded (12–15") and incorporated 2–4" deep in soil
Mocap EC (ethoprop)	5.1–6.9 fl oz/100 row-ft	2–3 weeks before planting	Banded (12–15") and incorporated 2–4" deep in soil
Majestene (dead <i>Burkholderia</i> bacteria) ³	4–8 quarts/a. Multiple applications may be made.	Any or all of: Before planting At planting 3. Post-planting	Shank, broadcast spray, banded/ in-furrow spray, drench, or chemigation depending on timing. See label for details.
Melocon WG (live <i>Purpureocillium lilacinus</i> fungi) ³	6–9 lb/a per application	1. Up to 21 days before planting <i>and</i> 2. At planting	1. Preplant banded or broadcast spray. 2. Drench in transplant water.
Nimitz (fluensulfone)	3.5–7 pt/treated a (banded applications not to be concentrated in row)	At or before planting	Broadcast or banded spray. Incorporate by tillage and irrigate in, if possible. Overhead or drip irrigation.
Velum (fluopyram)	6.5 to 6.84 oz/acre per application. 13.7 oz/acre per year. ⁵	Flexible (>7 days before harvest)	1. Preplant or postplant drench 2. Overhead irrigation 3. In-furrow spray
Vydate L (oxamyl)	1. 2 gal/treated a (preplant) 2. 1–2 gal/a (at-plant) (No more than 3 g/a total)	1. 7 days or less before planting 2. At planting	1. Broadcast or banded spray incorporated 4–6" deep in soil 2. Drench in transplant water

¹ Provided as guidelines only. Information is subject to changing product registration and labeling. Always read and follow label instructions. The mention of a product or trade name does not imply endorsement to the exclusion of other products. Ethoprop and oxamyl products are restricted-use pesticides for use only by state-certified applicators or persons under their direct supervision.
² Do not exceed greatest listed label rate. Only 1 application per growing season is allowed unless noted otherwise.
³ Majestene and Melocon WG are OMRI-listed organic nematicides.

Table 6. Characteristics of non-fumigant products in Florida sweet potato.

Trade Names (Active Ingredient)	Handler Toxicity Category ¹	Soil Movement (Water Solubility)	Persistence in Soil (Half-Life)	Systemic in Plant?	Relative Efficacy against Nematodes ²
Mocap 15G or EC (ethoprop)	Danger	High (843 ppm)	Short (3–56 days)	No	Fair to good
MeloCon WG (live <i>Paecilomyces</i> fungi)	Caution	N/A	N/A	No	Poor to fair
Majestene (dead <i>Burkholderia</i> bacteria)	Caution	N/A	N/A	No	Poor to fair
Nimitz (fluensulfone)	Caution	Medium (545 ppm)	Short (7–17 days)	No	Fair to excellent
Velum (fluopyram)	Caution	Low (10 ppm)	Long (162–746 days)	Yes, limited movement	Fair to good
Vydate L (oxamyl)	Danger	High (240,000 ppm)	Short (7 days)	Yes	Fair to excellent

¹ EPA-designated terms on product labels to alert handlers to toxicity hazards. “Danger” is the greatest hazard level, followed by “Warning” and “Caution.” Ethoprop and oxamyl are restricted-use pesticides.

² Efficacy scale is none to excellent. Efficacy may vary by situation and should be used as a guide only. Most products have not been tested side-by-side in sweet potato trials. Rating is based on published and unpublished Florida research trials in both sweet potato and other vegetables (Rhoades 1987; Hewlett et al. 1988; Watson and Desaegeer 2019; Grabau et al. 2019; Liu and Grabau 2019; Desaegeer and Watson 2019; Grabau and Liu 2019a; Grabau and Liu 2019b).