ENY-010

UF UNIVERSITY of FLORIDA
IFAS Extension

Nematode Management for Sod Production in Florida[1]

William T. Crow[2]

A study in 1991-92 found 4.4 million acres of turfgrass were grown in Florida, this acreage increases each year. A healthy sod industry is critical to supply the great demand for turf in the sunshine state. Plant-parasitic nematodes (Figure 1) are capable of doing extensive damage to sod turf and are one of the most difficult to manage of all the sod pests. Additionally, infested sod can be a source of nematode spread to new locations when it is planted. Nematode problems on sod farms are expected to become even more common as methyl bromide, the most common and effective pre-plant treatment, begins being phased out.

What Are Nematodes?

Nematodes are unsegmented roundworms, different from earthworms and other familiar worms that are segmented (annelids) or in some cases flattened and slimy (flatworms). Nematodes living in soil are very small and most can only be seen using a microscope (Figure 2). There are many kinds of nematodes found in the soil under any sod farm. Most of these are beneficial, feeding on bacteria, fungi, or other microscopic organisms. There are even nematodes that can be used as biological control organisms to help manage important turf insect pests.

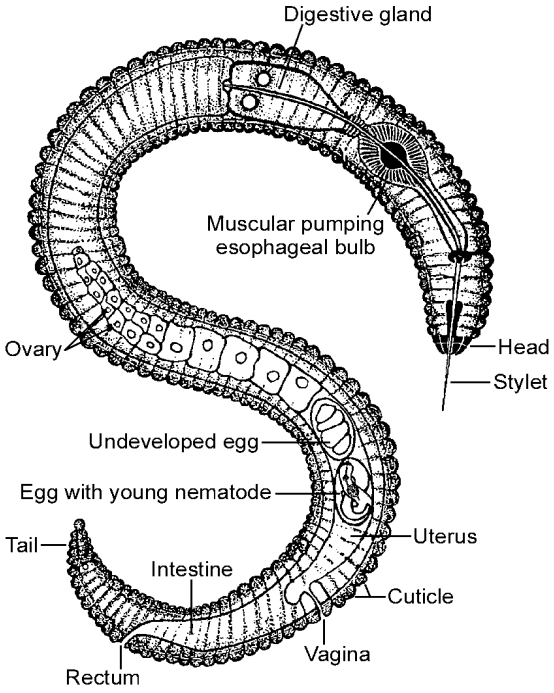

Figure 1. Diagram of a typical plant-parasitic nematode.

Unfortunately, there are also a group of nematodes that feed on plants, these are called plant-parasitic nematodes (Figure 1).

All plant-parasitic nematodes have a stylet or mouth-spear that is similar in structure and function

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2. William T. Crow, assistant professor, Entomology & Nematology Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

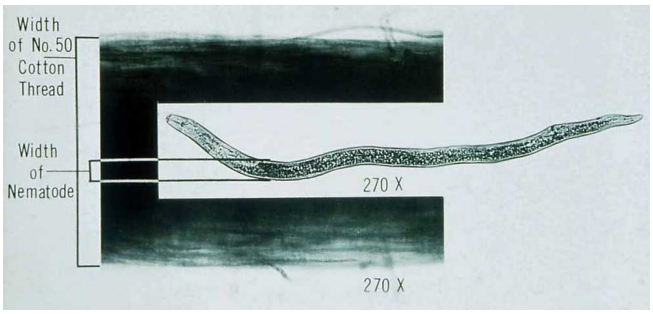

Figure 2. Size comparison of a typical plant-parasitic nematode to a cotton thread.

to a hypodermic needle (Figure 3). The nematode uses the stylet to puncture plant cells, and then inject digestive juices and ingest plant fluids through it. All of the plant-parasitic nematodes that are important turfgrass pests feed on roots. Some plant-parasitic nematodes remain in the soil and feed by inserting only their stylet into the root, these are called ectoparasitic nematodes (Figure 4). Others, using their stylet to puncture an entry hole in the root, feed with their body inside the root tissue. These are called endoparasitic nematodes (Figure 5).

Figure 3. A typical plant-parasitic nematode stylet resembles a hypodermic needle.

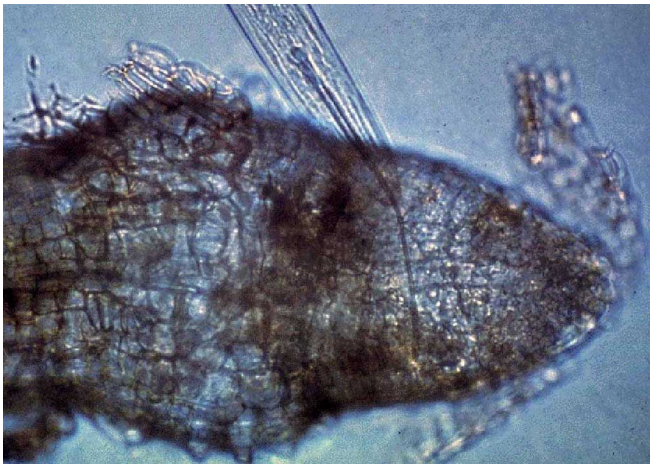

Figure 4. An ectoparasitic nematode feeding by inserting its stylet into a root tip.

Figure 5. Endoparasitic nematodes burrowing within a root.

How Do Nematodes Affect Sod?

As plant-parasitic nematodes feed they damage the root system and reduce the ability of the grass to obtain water and nutrients from the soil. Roots may be abnormally short and appear darkened or rotten when damaged by plant-parasitic nematodes (Figure 6). Often the roots will appear “cropped off” an inch or so below the soil surface (Figure 7). Root galls or knots associated with certain nematode damage to other crops are usually not evident on grasses.

Figure 6. Healthy grass roots (left) and dark, rotting grass roots damaged by nematodes (right).

When nematode population densities get high, and/or when environmental stresses such as high temperatures or prolonged low light occur, aboveground symptoms may become evident. Symptoms include yellowing, wilting (Figure 8), browning, or thinning out. Grass will die under extreme nematode and environmental stress. Often, as the grass thins out weeds, particularly spurge (Figure 9), sedge, (Figure 10) or Florida pusley (Figure 11) may become prominent. Nematode damage usually occurs in irregularly shaped patches that may enlarge slowly over time (Figure 12). On

Figure 7. Healthy bermudagrass roots (right) and roots that have been cropped off at about 1/2 inch deep by nematodes (left).

sod farms plant-parasitic nematodes often cause slow regrowth following sod harvest (Figure 13). High populations of plant-parasitic nematodes also can cause sod to not “hold together” and thereby make harvest impossible. Be aware that all these symptoms may be caused by other factors such as localized soil conditions, fungal diseases, or insects.

Figure 8. Centipede sod infested with sting and ring nematodes. Untreated area (right) shows wilting compared to the nematicide treated area (left).

Sting nematodes are the most damaging of the plant-parasitic nematodes and can damage all types of turf grasses, even occasionally Bahiagrass. Lance nematodes can damage all types of turf but are the most common nematode causing damage to St.

Figure 9. Spurge, a weed often associated with turf declining from nematode injury.

Figure 10. Sedge, a weed often associated with turf declining from nematode injury.

Figure 11. Florida pusley, a weed often associated with turf declining from nematode injury.

Augustine. Ring nematodes are common problems on centipede, but only rarely do they damage other grasses. Other common nematodes that occasionally damage turf on sod farms in Florida are stubby-root nematodes, root-knot nematodes, awl nematodes, sheath nematodes, and sheathoid nematodes. Nematodes that are common but rarely damage turf sod in Florida are lesion, stunt, and spiral nematodes.

Figure 12. Nematode damage usually occurs in irregularly shaped patches.

Figure 13. Nemtodes can cause slow regrowth following harvest.

How Do I Know If Nematodes Are A Problem?

With any plant problem, having an accurate diagnosis is important to address the problem and to avoid wasting effort and unnecessary pesticide applications. The only reliable way to determine if plant-parasitic nematodes are involved in a grass problem is by having a nematode assay conducted by a professional nematode diagnostic lab. The Florida Nematode Assay Lab is such a facility and will assay nematode samples for a cost that is currently $20 for each sample from Florida and $25 for each sample from outside of Florida. Nematode sample kits containing everything needed to collect and submit a sample, along with instructions, are available at your local county Cooperative Extension office.

Nematode analysis is a separate procedure and requires different sampling guidelines than those required for soil analysis or plant disease samples. Be aware that when a plant disease sample is submitted to most labs a nematode analysis is not normally performed unless you specifically request it. Nematode analysis often requires separate payment and may even be sent to a separate address. Familiarize yourself with the procedures required by the lab where you intend to submit the sample. The accuracy of the diagnosis depends on the quality of the sample that you submit. If you are taking a sample for submission to another lab, or if you are submitting a sample to the University of Florida lab without using our sample kits, following the guidelines below will help insure an accurate diagnosis:

1) A sample must consist of multiple soil cores. Nematodes are not evenly distributed in soil, but rather congregate in “hot spots.” Nematode populations may be high at one spot and low just a few feet way. By collecting multiple cores with a device such as a “T” type soil sample tube (Figure 14) an average population density can be measured. A good rule of thumb is to have a minimum of 20 cores per field. Cores should be taken to a depth of 3 inches.

Figure 14. A "T" type soil sample tube is ideal for collecting nematode samples from turf.

2) If damage is evident then sample near the margin of the affected area (Figure 15). Nematode populations will decline in severely damaged areas because they have nothing left to eat. Therefore, populations tend to be highest near the edges of a declining area where the grass is still alive. If damage is occurring in a number of areas in one field take a few cores from the border of several affected areas to make the 20 cores.

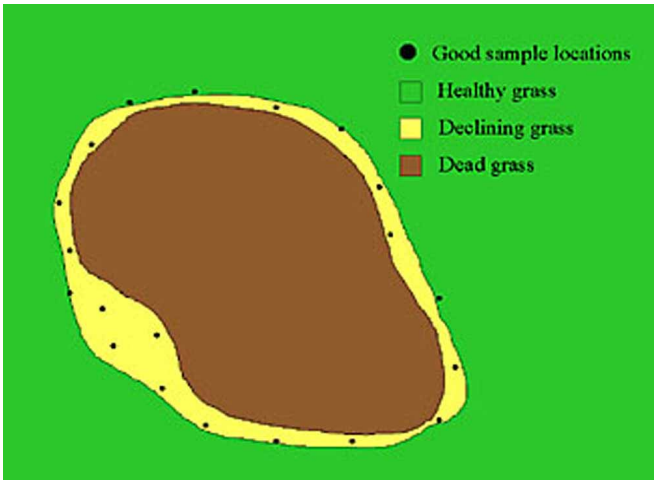

Figure 15. Collect cores for a nematode sample from the edges of declining areas.

When taking samples from turf that is not showing symptoms, or if sampling before planting, sample in a “zig-zag” pattern across the area (Figure 16). It is recommended that sod be sampled soon after lifting to get maximum benefit from nematicides if they are needed. If sod is ribbon cut, collect the samples from the ribbons and not the bare areas. For rhizominous grasses that are solid cut, collect samples in a “zig-zag” pattern across the area (Figure 16).

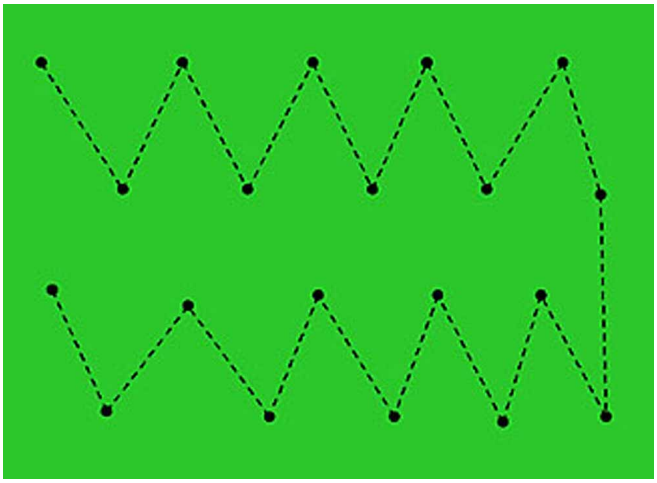

Figure 16. When sampling healthy appearing turf, or taking preplant or postharvest samples, collect cores in a zig-zag pattern across the area.

3) Put the soil from each sampled area into a plastic bag and seal it. Nematodes require moisture to survive so drying the soil will kill them. This is different than submitting a sample for nutrient analysis where dry soil is preferred. Make sure that each bag is labeled with a permanent marker so that the diagnosis can be assigned to the correct area. If using a self-sealing bag seal it with tape also because the zippers often come open in transit.

4) Handle samples carefully. Do not expose samples to direct sunlight or heat. Nematodes are sensitive to high temperatures and UV light. Leaving samples on the dashboard or in the back of a pickup truck can kill them quickly and negatively affect the accuracy of the diagnosis. Keeping the nematode sample in a cooler is best.

The nematodes will be sandwiched between soil particles so rough handling will destroy them. For shipping and transport pack the samples well to minimized shifting.

5) Submit the sample right away. Next day delivery is best. One study found greatest nematode recovery from hand-delivered samples, the next highest from next-day delivery, and the lowest from regular postal delivery.

The staff at the Florida Nematode Assay Lab will make a determination on whether or not nematodes are a problem based on which nematodes are found and how many of them there are. Not all plant-parasitic nematodes are equal in their ability to harm grass. For example, one sting nematode can cause damage equal to hundreds of individuals of some other types of plant-parasitic nematodes. The number of each type of nematode in 100 cc of soil from the sample that you submit will be used to determine the risk level for the turf species indicated (Table 1). The risk level will tell you if the turf is at low, moderate, or high risk of damage from plant-parasitic nematodes.

Be aware that different diagnostic labs may use different extraction techniques, use different quantities of soil, or use different thresholds. Because of this, samples submitted to separate labs may report different quantities of nematodes. Do not be alarmed by this, in most cases the different thresholds used are adjusted to account for the differences in methodology and local conditions. However, if you are using a lab in distant locations, your local conditions or regional variations in nematode aggressiveness may not be taken into account. Often

your local labs will provide the most accurate assessments.

How Do I Manage Nematodes?

Before Planting

It is always preferable to avoid a potential problem than to deal with an existing one, so it is best to consider nematodes before planting. Currently, chemical management of nematodes before planting is achieved by practicing soil fumigation. Soil fumigation involves injecting a liquid or incorporating a granular material into the soil. The material then either coverts to a gas or releases a gas that kills the nematodes. In addition to nematodes, many of the fumigants have activity against weeds and/or soilborne diseases and/or insects as well. Several soil fumigants are currently available for sod farm use. For detailed information on soil fumigation see the Florida Cooperative Extension Service document "Soil fumigation before planting turf" available at your County Cooperative Extension office or on-line at http://edis.ifas.ufl.edu/IN095.

Established Sod

Cultural Practices

Turf can often exist with a given population density of plant-parasitic nematodes with no visible damage. Damage usually becomes evident when one of two things occur; 1) some other factor increases the susceptibility of the grass to nematode damage and/or 2) some factor causes nematode population densities to increase to damaging levels. Once the grass is planted, the best way to reduce the likelihood of nematode damage is to minimize these factors as much as possible.

Fertility:

Excessive nitrogen fertilization can increase succulent root growth and encourage rapid foliage growth. Succulent root tips are more susceptible to nematode damage, and the proliferation of root tips (nematode food) can cause nematode population densities to rise dramatically. Rapidly growing foliage drains nutrient reserves from the roots that are needed to compensate for the nematode damage.

Under-fertilization should also be avoided. Roots damaged by nematodes will already have a reduced capability to extract nutrients from soil. This makes nutrient deficiencies more pronounced on nematode-infested plants.

Watering:

Deep, infrequent watering encourages deep root growth. A deep root system is more tolerant of nematodes than a shallow root system resulting from shallow, frequent watering. However, once nematode damage is extensive, frequent watering may be required to keep the grass from wilting. In this case water should be applied only often enough to avoid wilting and only enough to allow water penetration as deep as the root system.

Chemicals

Nemacur: Fenamiphos is the active ingredient in Nemacur 10%, a nematicide that can be used to suppress nematodes on established sod. Nemacur 10% has a supplemental label for use on sod farms in Florida only. The supplemental label must be in the possession of anyone applying Nemacur on sod. Nemacur is currently under a phase-out and will no longer be produced as of May 2007. However, sales of existing stock may continue through May 2008. Additionally, Nemacur can no longer be used on certain areas defined on the label which states Do not apply to hydrologic soil group A soils that are excessively drained and predominately sand or loamy sand such as soils in the suborder psamments with shallow water tables (less than 50 feet deep). These classifications and soil taxonomy refer to USDA definitions. If you are unsure of the type of soil you are treating, please consult with your county's extension agent or the product manufacturer. See the Bayer Procentral website for more information regarding the phase-out of Nemacur.

Fumigants:

Soil fumigants are commonly used to disinfest soil before planting. Two soil fumigants also may be used to manage nematodes after planting. These fumigants are applied using slit-injection equipment mounted on tractors. The fumigants are injected into the soil as a liquid, but then convert to a gas in the

soil. The gases diffuse through the soil and kill nematodes on contact.

Have a nematode assay conducted immediately after lifting to determine if nematodes are a potential problem on the next crop. Because the fumigants must be injected with knives or colters, mechanical cutting of the sod occurs. Enough time must be allotted between application and harvest to allow the sod to knit back together. Usually 100 to 120 days is sufficient. Treating soon after lifting can greatly speed up grow-in time in nematode infested soil and improve sod strength at harvest. Clearly, the sooner the sod is treated after lifting the better to maximize benefits.

1,3-Dichloropropene: This is the active ingredient in the Telone products. Telone II has a FIFRA special 2(ee) label for nematode control on re-growth sod. According to this label, Telone II should be applied at 5 gallons or more per acre. Injection depth should be at least 5 inches, but deeper injection will increase efficacy. In University of Florida tests 1,3-dichloropropene applied by this method gave excellent control of sting and certain other nematodes and mole crickets, and also improved sod strength. Telone II should never be injected as deep as the water table to prevent groundwater contamination. According to the product label, 1,3-dichloropropene cannot be used on areas with Karst geology, or within 100 feet of buildings or wells.

Metam sodium: Sodcure 376 is a metam sodium fumigant used for nematode control on established sod. Other metam sodium products are not labeled for this use and may be applied only for preplant fumigation. Sodcure 376 may only be applied by custom application, at present there is only one applicator in the state of Florida.

Other Products:

A great deal of emphasis is being placed on finding less-toxic nematode control products. Many of these are “biological derivatives” of plants or microorganisms or “biological control” products. Others are non-biological, but are marketed as “non-toxic” or “organic.” These types of products often are safe, but do not need to be proven to be effective to be labeled.

Faculty at the University of Florida are committed to testing as many of these products for efficacy as possible. Additionally, we network with researchers at other institutions to gather their experience working with these products. While we have data on many of these products, we do not have data on all of them. Feel free to contact us for information on our experience with specific products.

Summary

Nematode management on sod can be a daunting task. The University of Florida is committed to bringing you the most current information possible. Consequently this document will be modified with each breaking development. The most current version of this document may be obtained at your County Cooperative Extension office, or found on line at the University of Florida's Electronic Document Information System (EDIS) website at http://edis.ifas.ufl.edu/.

For additional information regarding nematodes, nematode management, or help interpreting nematode assay results contact:

Dr. W. T. (Billy) Crow, Landscape Nematologist, Entomology and Nematology Dept., PO Box 110620, Gainesville, FL 32611, (352) 273-3941, FAX (352) 392-0190, Email: wtcr@ufl.edu

For information on submitting samples to the University of Florida Nematode Assay Lab or to check on the status of a sample you submitted contact:

Mr. Frank Woods, Senior Biologist, Nematode Assay Lab, PO Box 110820, Gainesville, FL 32611, (352) 392-1994, FAX (352) 392-3438, Email: nemalab@ifas.ufl.edu.

Table 1. Risk Levels for Warm-Season Turfgrasses used by the Florida Nematode Assay Laboratory.

Nematode Species	Bermuda		Zoysia		Seashore paspalum		St. Augustine		Centipede	
	M	H	M	H	M	H	M	H	M	H
Root-knot (*Meloidogyne*)	80	300	80	300	80	300	80	300	80	300
Sting (*Belonolaimus*)	10	25	10	25	10	25	25	50	10	25
Lance (*Hoplolaimus*)	40	120	40	120	40	120	40	120	40	120
Stubby-root (*Paratrichodorus*)	150	300	150	300	150	300	40	120	150	300
Stubby-root (*Trichodorus*)	40	120	40	120	40	120	40	120	40	120
Spiral (*Helicotylendhus*)	700	1500	700	1500	700	1500	700	1500	700	1500
Spiral (*Peltamigratus*)	150	300	150	300	150	300	150	300	150	300
Ring (*Mesocriconema*)	500	1000	500	1000	500	1000	500	1000	150	300
Sheath (*Hemicycliophora*)	150	300	150	300	150	300	150	300	150	300
Sheathoid (*Hemicriconemoides*)	500	1000	500	1000	500	1000	500	1000	150	300
Awl (*Dolichodorus*)	10	25	10	25	10	25	10	25	10	25
Cyst (*Heterodera*)	---	---	---	---	---	---	10	40	---	---

Key:
--- = not believed to cause significant damage .
M = Turf is considered at moderate risk of damage. Damage may become evident if the turf is placed under stress conditions.
H = Turf is considered at high risk of damage. Root systems are likely damaged and turf quality may be declining.

* These risk levels are based upon numbers per 100 cc of soil extracted using a sugar-flotation with centrifugation method.
** While bahiagrass is a host for many of these nematodes, it is very tolerant to them and seldom is damaged. Therefore, no risk levels are given.
*** Other nematodes such as dagger, lesion, stunt, etc. may damage turf in Florida, but damage from these is very rare so risk levels are not listed.
**** These risk levels are based upon nematodes, grasses, and conditions in Florida only. They may not apply in other states.