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Nematodes in Texas Golf Courses

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Nematodes are unsegmented roundworms. Most are microscopic. All nematodes are aquatic animals, and soil nematodes live in the thin films of water surrounding soil particles. Not all soil nematodes damage turf; in fact, most are beneficial and help cycle carbon and nitrogen in the soil environment. However, plant-parasitic nematodes feed on living plant tissue and can harm turfgrass.

A typical plant-parasitic nematode is equipped with a hollow stylet or mouth spear. The stylet resembles a hypodermic needle, and has a similar function. The nematode inserts its stylet into the root cells of a plant and injects digestive enzymes through it. The nematode then uses the stylet like a straw to remove the partially digested cell contents. The digestive secretions injected by different nematodes have different effects on roots. This is one reason why some plant-parasitic nematodes cause more damage than others.

Symptoms of Nematode Damage to Turf

The damage nematodes cause to turf grasses is difficult to distinguish from the damage caused by water stress, nutrient deficiency or root diseases. Turf may turn yellow and/or wilt during the heat of the day because the damaged root systems cannot supply adequate nutrients and water to the plant. The turf may become thin, which often allows weeds to grow in affected areas. In severe cases, the turf may turn brown and die. Roots may have swellings, lesions, or a stubby appearance, or appear dark or undeveloped.

Nematodes are not evenly distributed in the soil, but congregate in "hot spots." Population densities may be very high in one area, and low just a few feet away. Because of this uneven distribution, nematode damage usually occurs in patches rather than uniformly across an area. Nematode damage is more evident on greens than fairways because greens are more intensively managed, are mowed at lower heights, and have more traffic, all of which puts the grass under greater stress.

Because nematode damage my be indistinguishable from other problems, diagnosis should not be based on symptoms alone. Proper diagnosis of a nematode problem can be made only by means of a soil test.

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Testing for Nematodes

The first step in managing nematodes is to properly identify the problem. This should be done by a credible diagnostic lab. Different diagnostic labs process the samples differently and, therefore, the number of nematodes recovered can vary from lab to lab. However, each lab uses thresholds developed for its extraction method, so the final recommendations (whether or not to treat) shouldn't vary.

Texas A&M University has an excellent nematode diagnostic facility and will process soil samples for a charge of $20 each. Submission forms can be obtained from your county Extension office, from the Web *(http://plantpathology.tamu.edu/index4.html)*, or ordered from the following address:

Texas Plant Disease Diagnostic Laboratory
Texas A&M University Research Park
1500 Research Parkway
College Station, Texas 77845

Figure 1. This sting nematode ***(Belonolaimus longicaudatus)*** is feeding on a root tip.

Soil testing for nematodes is different from soil nutrient testing, so the sampling procedure is also different. The accuracy of the test results depends on the quality of the sample, so the soil must be collected and handled correctly.

Because nematodes are not evenly distributed in the soil, a sample must consist of multiple cores. If there are no above-ground damage symptoms, take at least 20 cores from random locations across the sample area (Fig. 1). If symptoms are visible, take at least 20 cores from the margins of the affected area (Fig. 2). Nematodes feed on living tissue, so the highest populations of nematodes will be near the edges of affected areas, not where the plant damage is most severe.

The best tool for taking a nematode sample is a 3/4-inch-diameter "T" type sampling tube (Fig. 3). Take the cores to a depth of 2 to 3 inches, where most of the plant roots are located. Deeper sampling will lower the quality of the sample.

Place all the cores into a single plastic bag and seal it tightly. Do not use a paper bag. Nematodes require moisture to live, and if the soil sample dries out the diagnosis will not be accurate. Remove the sample from direct sunlight as soon as possible and store it in a cool place, but do not let it freeze. Soil in plastic bags can heat up rapidly and heat kills nematodes. Handle the soil sample gently; the nematodes are sandwiched between soil particles and rough handling will destroy them.

Deliver the sample to a diagnostic lab as soon as possible. Studies show that more nematodes are recovered from hand-delivered samples than from mailed samples. If you must mail the sample, place it in an insulated container, pack it well to prevent shifting, and send it by overnight mail.

With your sample, provide as much information as possible about the symptoms you've observed and the history of plantings in the area sampled. If pesticides have been applied recently, the lab must be notified. Pesticide residues can be dangerous to the diagnostician who processes the sample.

The test results you receive will indicate the genera and densities of nematodes recovered in your sample, and the lab will recommend treatment for particular species if warranted. The threshold population densities labs use to make such recommendations are rough estimates only. But nematode population isn't the only factor that affects the amount of damage they cause. Other factors are the variety of grass, environmental stresses (temperature, watering, mowing height, etc.), and the interactions between differ-

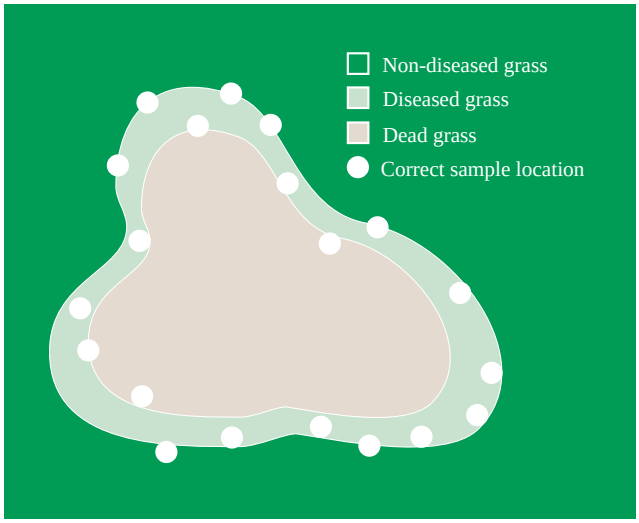

Figure 2. When collecting soil samples from turf that shows symptoms of nematode damage, take at least 20 cores from near the margins of the affected area.

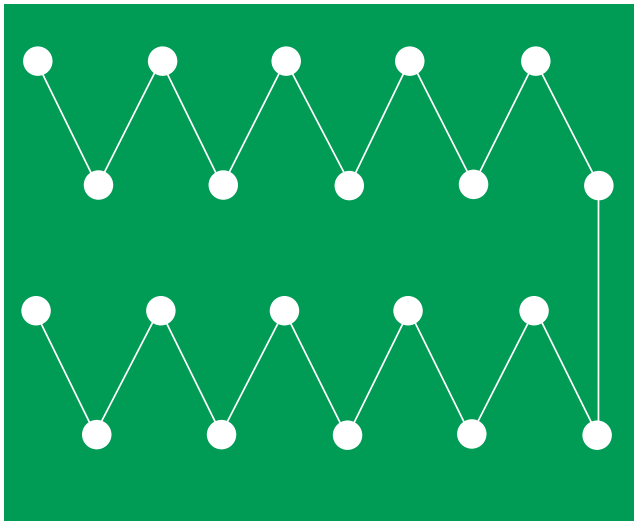

Figure 3. When collecting soil samples from turf that has no visible symptoms, take at least 20 cores in a zig-zag pattern as shown.

ent types of nematodes and between nematodes and other pathogens.

Most of the research that established threshold populations was done on Bermuda and St. Augustine grasses. The same thresholds are used for other turf grasses such as bentgrass and zoysia. More research is needed to establish thresholds for these grasses and for various environmental conditions.

Which Nematodes Affect Turf?

There are many types of plant-parasitic nematodes that damage turf grasses. With certain species, relatively few nematodes can cause a great deal of damage, whereas with other species, a much greater number is required to cause any visible damage. Most nematodes remain in the soil and insert only their stylets into the root (ectoparasites). Some enter the root and remain there (endoparasites). Still others enter the root with only part of their body (semi-endoparasites).

The following species may be reported on diagnostic test results and are listed in order of their ability to damage turf grasses.

Sting nematode ***(Belonolaimus longicaudatus):*** This is probably the most damaging nematode to turf grasses (Fig. 4). Relatively few sting nematodes can devastate a root system. They are ectoparasites and thrive in soil with more than 80 percent sand content. USGA specifications for putting green construction require 90 percent sand content in the root zone mixture, an ideal habitat for the sting nematode.

Awl nematodes ***(Dolichodorus*** **ssp.*):*** Awl nematodes are rare in Texas, but are as damaging as sting nematodes. Awl nematodes are usually found only in moist soil near ponds or ditches, and are ectoparasitic.

Lance nematodes ***(Hoplolaimus*** **ssp.*):*** Lance nematodes also can be very damaging to turf grasses. They are more common in Texas than sting nematodes, and are more common in soils with a higher silt and clay content than are sting nematodes. The lance nematode is a semi-endoparasite.

Stubby root nematodes ***(Paratrichodorus*** **spp.,** ***Trichodorus*** **ssp.*):*** These ectoparasitic nematodes are frequently detected in Texas turf samples, and are considered damaging to turf grasses.

Root-knot nematodes ***(Meloidogyne*** **spp.*):*** With these endoparasites, the adults remain within roots and only juveniles are detected in soil samples. This makes it difficult to estimate population densities from soil analysis. Therefore, the amount of damage they cause is not well known.

Ring nematodes ***(Mesocriconema*** **and related genera):** These ectoparasites are the most frequently detected nematodes in Texas turf samples, but they are considered damaging only when very high numbers are present. Centipede grass is the most susceptible to damage from ring nematodes.

Figure 4. A "T" type soil sampling probe is the best tool for collecting nematode samples.

Lesion nematodes ***(Pratylenchus*** **ssp.*****):*** These common nematodes are generally considered only moderately damaging to grasses; however, their effects have not been thoroughly studied. They are endoparasites.

Others. Other nematodes found in Texas golf courses include **spiral** (***Helicotylenchus*** **and related genera*****),*** **stunt** ***(Tylenchorhynchus*** **and related genera), sheath** ***(Hemicycliophora*** **ssp.**), **sheathoid** ***(Hemicriconemoides*** **ssp.*****),*** and **pin** ***(Paratylenchus*** **spp.) nematodes.** These nematodes may cause damage when their numbers are high.

Management

During construction or reconstruction of greens, soil can be treated with one of several fumigant nematicides to reduce nematode populations before planting. While methyl bromide was commonly used in the past to disinfect soil from nematodes, weeds, insects and diseases, this chemical is being phased out because of its ozone-depleting properties. Other fumigant nematicides currently labeled for use in green construction and reconstruction include: dasomet (Basamid®); 1,3-dichloropropene (Telone® products); and metam-sodium (several brand names). Be careful not to use nematode-infested sod. It is advisable to have the sod tested before planting.

If treatment is recommended for established turf on commercial golf courses, there are several nematicides labeled for use in Texas. Some of the more common and effective of these are fenamiphos (Nemacur® products), ethoprop (Chipco Mocap®), and 1,3-dichloropropene (Curfew®). Nematicides with a systemic mode of action are more effective against endoparastic nematodes within plant roots then are some other products. Be aware that not all nematicides labeled for turf have been consistently effective in university trials. Carefully follow directions on the product label to ensure safety and to prevent phytotoxicity.

Because the effects of nematodes can be amplified when grass is under stress, manage infested turf to minimize stress by raising the mowing height, applying adequate fertilizer, and watering deeply to encourage deep rooting.

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