Nematodes — How Do I Know If I Have a Problem?

Concern about nematodes is increasing among golf course superintendents nationwide.

BY BILLY CROW, PH.D.

Figure 1. This recently renovated ultradwarf bermudagrass putting green is infested with sting nematodes.

Nematodes were once considered a problem that only affected golf courses in the southeastern United States. Now, however, there is increasing concern about nematodes among golf course superintendents nationwide. Are nematodes really becoming more of an issue and, if so, why? Should you be concerned? How can you tell if nematodes are a problem at your golf course?

FACTORS CONTRIBUTING TO INCREASING NEMATODE PROBLEMS

Nematodes are an increasing problem on golf courses both in fact and perception. Some of this is due to changing agronomic practices, but there are other contributing factors as well. Golfer expectations and industry standards have changed, pest management in general has become more complicated, pesticides are becoming more targeted, and superintendents are treating for more specific pests. As pest issues are addressed, the areas that chronically underperform despite best management practices become more visible and create more concern about nematode pressure. This concern can be further amplified by the marketing campaigns used to promote nematicides.

Generally, nematode problems are more common in warmer climates, where they are more active and produce more generations. However, some species of plant-parasitic nematodes are well adapted to cool climates. Although significant nematode damage is less frequent in northern states, it still occurs.

The widespread adoption of sand-based putting green construction has been a contributing factor to the increased frequency of nematode issues. Sand-based putting greens facilitate rapid drainage, reduce issues associated with compaction, and improve playability; however, some of the more virulent nematode species also favor sandy soils. By modifying putting green soils to improve turf performance and playing conditions, the golf industry has inadvertently created an ideal habitat for some nematodes that otherwise would seldom be

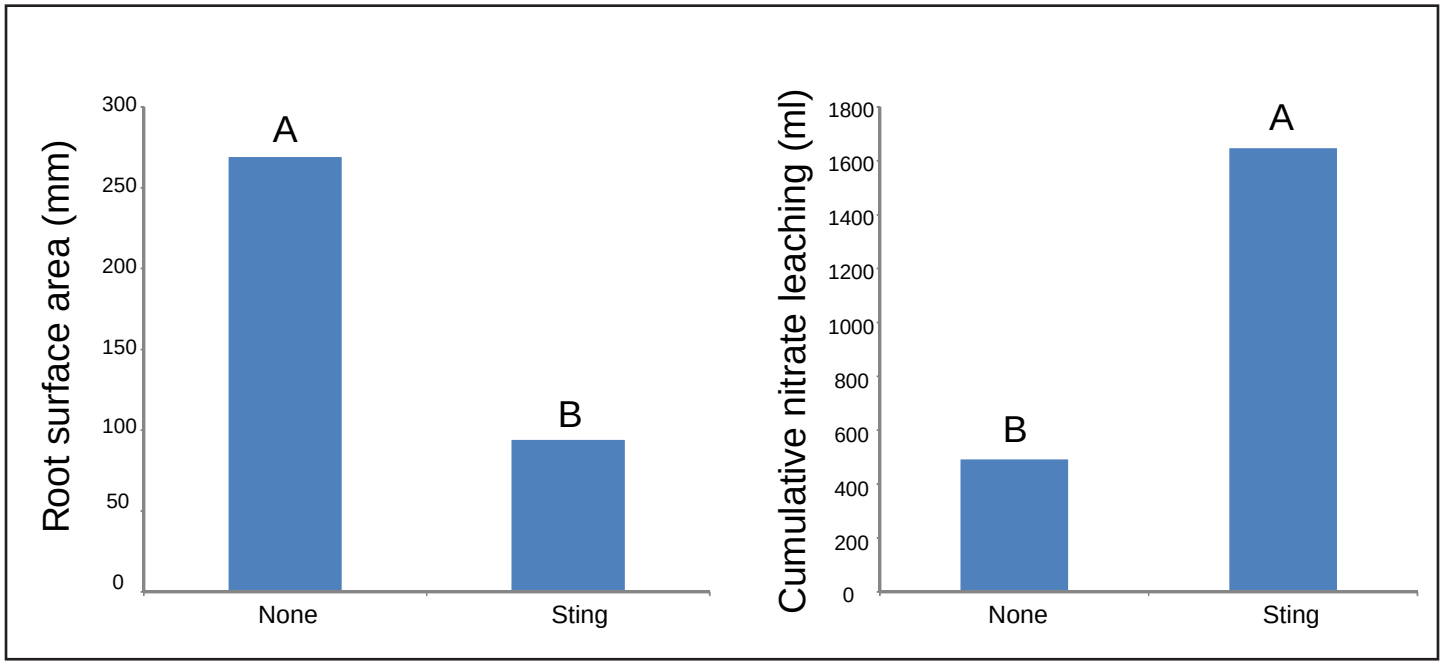

Figure 2. Effects of inoculation with sting nematodes on Tifway bermudagrass average root surface area and cumulative nitrate leaching over a two-year period. Nematodes can potentially contribute to fertilizer leaching because nematode-damaged roots are less able to extract nutrients.

a problem. For example, root-knot nematodes (*Meloidogyne minor*) were seldom a problem on push-up greens in the United Kingdom. However, as more sand-based putting greens were constructed throughout the United Kingdom, pest pressure from root-knot nematodes started to become an issue at some facilities. Similarly, sting nematodes (*Belonolaimus longicaudatus*) only thrive in very sandy soil and were once only found in sandy coastal areas in the southeastern United States. However, sting nematodes are regularly found in sand-based greens well outside their endemic range.

Human activity also helps spread nematodes, along with other pathogens and pests, to new areas. Sting nematodes have been spread with contaminated plant material as far west as California and as far north as Ohio. Similarly, the stem-gall nematode (*Anguina pacificae*) from California recently has been found in Ireland. It is believed that the stem-gall nematode may have traveled to Ireland on contaminated equipment. Over time, destructive nematode species are being moved into new regions where they once were not present.

Probably the biggest factor leading to increasing nematode concerns on golf courses is golfer demands. Golfers want low mowing heights and fast green speeds, but meeting those demands makes turf less tolerant of nematodes. At the same time, there is increasing public, regulatory, and economic pressure to use less water, fertilizer, and pesticides. As the golf industry responds to these pressures, it is no surprise that nematodes are becoming more of a concern.

WHY ARE NEMATODES A CONCERN?

With the exception of the stem-gall nematode, the plant-parasitic nematodes that impact golf course turfgrasses feed on roots. These nematodes can weaken turf roots, making them less efficient at translocating water and nutrients. In severe cases, nematode activity can cause turf to wilt, decline, and die. Even when nematode damage is less severe, it can make turfgrasses less tolerant of environmental stresses, mechanical damage, and pesticide applications. Furthermore, the direct and indirect damage caused by nematodes can create poor-quality, inconsistent playing surfaces.

Shallow roots resulting from nematode damage are not able to extract water from deep within soil profiles. Therefore, increasing the frequency of irrigation or the amount of water applied often is required to keep turf with compromised roots alive. Research conducted at the University of Florida has shown that successfully managing even moderate populations of sting nematodes can significantly increase bermudagrass drought tolerance (Trenholm et al., 2005). Furthermore, several golf courses in Florida have reported that using effective nematicides has greatly reduced the amount of hand watering required to manage putting greens affected by sting nematodes. Using less water conserves resources, improves firmness, enhances soil oxygen levels, and creates an environment that is less conducive to disease development.

Nematodes also can potentially contribute to fertilizer leaching. Roots that have been damaged by nematodes are less able to extract nutrients than healthy turfgrass roots. Additional research at the University of Florida has shown that sting nematodes decrease the surface area of Tifway bermudagrass roots and increase cumulative nitrate leaching over a two-year period (Aryal, 2015) (Figure 2).

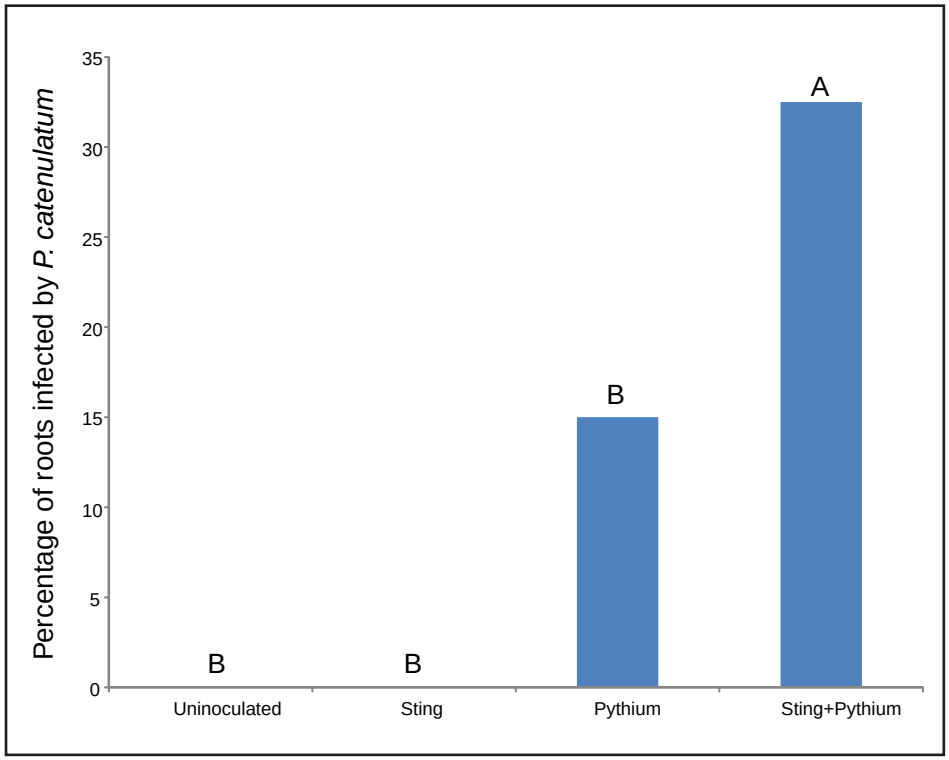

Figure 3. Effects of inoculation with sting nematode on bermudagrass root infection by Pythium catenulatum*. A recent study found that infection of bermudagrass roots by* Pythium spp. *is greater when sting or root-knot nematodes are present.*

Also, nematode damage can predispose turf to other pathogens or pests. Nematodes wound roots, thereby creating entry points for fungal pathogens, and can cause physiological changes that make turf more susceptible to disease. Ongoing research at the University of Florida studying the interactions between nematodes and *Pythium* root rot of bermudagrass have found that bermudagrass root infection by certain *Pythium spp.* is greater in the presence of sting or root-knot nematodes than when nematodes are absent. Further, some *Pythium spp.* can only infect roots damaged by nematodes (Figure 3). Nematode damage can also cause thin, weak areas of turf that allow weeds to proliferate.

In summary, nematodes can negatively impact the bottom line at a golf facility. Decreased turfgrass quality makes a golf course less enjoyable for golfers. Nematodes also can increase the need for irrigation, fertilizer, pesticide, and labor inputs to aid turf recovery or repair damaged playing surfaces.

HOW DO I KNOW IF NEMATODES ARE THE PROBLEM?

Most nematodes cause irregularly shaped patches of thinning, declining, or wilting turf that slowly grow in size over time (Figure 4). Root-knot nematodes may cause yellow, blotchy patches that are more circular in shape on bermudagrass and bentgrass putting greens (Figure 5).

Nematode-infested areas may have an increased number of weeds or experience fungal diseases that do not respond as expected to fungicides. Areas with high nematode populations may experience slower turf growth, causing putting greens to be rough or bumpy. Poor transition out of overseeding or poor overseeding establishment also can be caused by nematodes. However, all of these symptoms also can be caused by other factors, so deliberate diagnosis is imperative. Above-ground symptoms signify that there is a problem, but above-ground symptoms alone are not sufficient to accurately diagnose nematode damage.

To better diagnose nematode damage, look closely at the turf roots in weak, symptomatic areas. Many types of nematodes can damage turf roots in several different ways, and symptoms of one type of nematode may be different on different species of turfgrass.

MOST COMMON ROOT SYMPTOMS ASSOCIATED WITH NEMATODES:

- Cropped appearance just below the thatch layer (Figure 6)
- Dark and rotten appearance
- Lack of fine feeder roots
- Presence of galls or knots
- General lack of roots or weakened root system

SAMPLING TURFGRASS FOR NEMATODES

If turfgrass on a golf course is experiencing any symptoms of nematode activity, submit samples from damaged areas to a diagnostic lab. Diagnostic labs can help determine if and what types of nematodes are present as well as identify the size of nematode populations. Be aware that the preferred nematode sampling method may vary between labs and certain nematodes are more accurately diagnosed from soil and others from turf roots.

ASSESSING DIAGNOSTIC LAB RESULTS — TO TREAT OR NOT?

Generally, lab results will include a list and count of the plant-parasitic nematodes recovered from a certain volume of soil or plant tissue. Most labs will indicate if the population of a particular type of nematode is greater than a threshold level — i.e., a predetermined nematode population density above which damage can occur and control methods may be warranted. Some labs may even assign a level of risk based on their findings. Although this information is very important for managing nematode populations, there is a lot of misunderstanding about what these lab results mean and how they should be used.

Action threshold or risk levels for nematodes are general guidelines;

they are not rules. They are an educated guess about the severity of damage that could be caused by a certain number of a particular type of nematode to a particular kind of grass under defined conditions. The reality is that no one really knows exactly how many nematodes it takes to cause significant damage at a particular location.

First, almost all nematode diagnoses are done at the genus level, but different nematode species within the same genus can cause varying levels of damage. Even though some labs report nematode species, few of those labs routinely diagnose turf samples.

Second, different cultivars of the same grass species may respond differently to nematodes. Researchers at the University of Florida have identified certain bermudagrass cultivars that are more tolerant of sting nematodes than others (Pang et al., 2011). As a result, different risk thresholds for sting nematodes can be used for different bermudagrass cultivars. However, similar relationships between cultivar and nematode tolerance have not been established for other types of nematodes that infect bermudagrass or for other turf species used on golf courses.

Third, different nematodes can interact in different ways (Burrows, 1987). It is not uncommon to find as many as ten different genera of plant-parasitic nematodes in a single turfgrass sample. Research has found that some effects of nematodes may be additive. If nematode A causes a 10-percent reduction in roots and nematode B causes a 20-percent reduction in roots, the combined effect of nematode A and nematode B could be a 30-percent reduction in roots. Still, the effects of other nematode combinations can be multiplicative, so nematode A and nematode B together might even cause a 50-percent reduction in roots. Conversely, other nematodes can inhibit each other and reduce the damage that might be done by one alone (Crow et al., 2013). Unfortunately, the effect of interactions between most nematodes is unknown. Without a better understanding of nematode interactions, it is impossible to establish accurate thresholds for nematode combinations.

Finally, overall turf health also impacts nematode tolerance. Healthy turf can tolerate more nematodes than weak or stressed turf. Twenty-five sting nematodes per 100 cubic centimeters (cm^3) of soil will have an entirely different effect on plants with roots that are 0.75 inch deep than plants with roots that are 5 inches deep. After roots have been damaged, nematode numbers will decline because there is less food to sustain nematode populations. Therefore, larger nematode populations may be observed on heathy turf than on severely damaged turf.

Further complicating the idea of nematode thresholds, nematodes often interact with other turf pathogens. However, the extent to which these organisms interact is largely unknown. It may take 50 nematodes per 100 cm^3 of soil to cause direct damage, but it may only take 20 nematodes to make the turf susceptible to disease. There-

Figure 4. An ultradwarf bermudagrass putting green infested with lance nematodes exhibits thinning, decline, and a proliferation of weeds.

Figure 5. An ultradwarf bermudagrass putting green infested with root-knot nematodes may exhibit yellow blotches.

fore, nematode counts and thresholds should not be relied on as the sole factor in determining whether to apply a nematicide.

What if the turf looks great and the root system is healthy? Should a nematicide be applied only because nematode counts exceed a given threshold? In many cases the answer is no. However, the fact that a nematode count exceeds a threshold should serve as an alert to the potential for nematode damage. Carefully monitoring root health and submitting frequent nematode samples will aid diagnosis should conditions change.

On the other hand, a nematicide may be warranted if turf roots are struggling and a lab reports the presence of damaging nematodes, even though their population size does not exceed a threshold. Remember, fewer nematodes are more damaging to an already shallow root system. If areas with chronic root disease do not respond as expected to fungicides and damaging nematodes are found but their numbers are below threshold levels, nematicide applications may prove useful.

Despite the unknowns, combining nematode assays with direct observation and experience will help determine whether or not nematicide applications are warranted. Keep in mind new nematicides may work better on some nematodes than others. Laboratory tests that identify which nematodes present a potential issue are critical for selecting the most effective treatment. Armed with information about the type and quantities of nematodes present, treatment decisions can be made that account for conditions unique to any golf course — e.g., budget, quality demands, season, and other factors.

TAKE-HOME MESSAGES

Nematodes can pose a risk to golf courses, so nematode management is increasingly important for maintaining high-quality turf and conserving economic and environmental resources. Fortunately, there are new tools for managing nematodes. Determining if and when treatment is needed, and what treatment to apply, should be based on a combination of nematode assays, observation of turf and root health, and history at the site.

While the presence of nematodes may not necessarily justify treatment, it is important to be aware that a

Figure 6. Roots damaged by nematodes may appear cropped just below the thatch layer.

nematode-damaged root system can result in:

- Increased water use
- Increased fertilizer use
- Increased leaching potential of fertilizers and pesticides
- Turf that is less tolerant of environmental stress
- Increased disease and fungicide use
- Increased weeds and herbicide use
- Poor playing conditions

Nematodes are something new for many golf course superintendents and their staffs. Sometimes it is easy to let a sales distributor collect samples and submit nematode assays, then follow their recommendations regarding treatment. Some sales distributors are very knowledgeable and make good recommendations that are worth considering, but they are not on your golf course every day. The knowledge and experience of a superintendent are the most valuable resources a golf facility has for making decisions about nematode control. Closely examine roots, get educated about nematodes and their management, take samples, and use proper judgement.

Remember the old proverb "The best fertilizer is the gardener's shadow."

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