RESEARCH

Sting nematode: Not a steward of the environment

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Using nematicides to protect turfgrass may be more helpful to the environment than banning their use.

John E. Luc and William Crow, Ph.D.

A recent field survey found damaging populations of plant-parasitic nematodes on 87% of Florida golf courses. Although many superintendents struggle with these microscopic pests, the weapons in their arsenal have been depleted in recent years.

What would happen if no effective nematicides were available for use on turf? Certainly, some courses would become unplayable, some superintendents would lose their jobs and a great deal of money would be wasted. Beyond this, could there be negative impacts on the very environment that we are trying to protect?

In recent years, heightened environmental awareness has brought water quality and consumption to the forefront of public concern, focusing attention on users of water, fertilizers and pesticides (2). Nitrogen is normally the limiting nutrient in the turfgrass system (6). In Florida, golf courses have increased their use of nitrogen fertilizers, and maintained turf area on golf courses has increased by 12.7% over the past five years, adding to the public's concerns and spurring questions about the fate of nitrogen after application.

KEY points

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- **The sting nematode** damages turfgrass roots and restricts the plant's ability to take up water and nitrogen.
- **Healthy, established turf** takes up nitrogen fertilizer and prevents nitrate from leaching into the groundwater.
- **In greenhouse experiments, nematode** damage to turfgrass roots increased nitrate leaching.

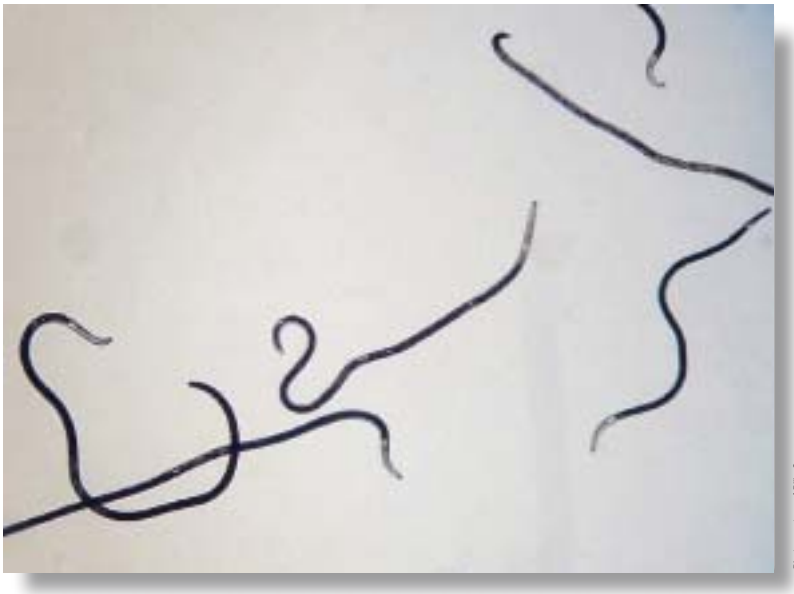

Photo courtesy of Billy Crow

Figure 1. The sting nematode (*Belonolaimus longicaudatus*) damages bermudagrass root systems so that the plant's water and nutrient uptake are decreased and plant growth is reduced.

Nitrate leaching

Nitrogen leaching into groundwater is one concern. Nitrogen leaching occurs when soil-solution nitrogen passes below the root zone. Leaching can occur when nitrogen fertilizers are applied to well-drained soils and rainfall or irrigation is increased. Nitrate is the most leachable form of nitrogen. Studies have shown that nitrate leaching from healthy turf is minimal (4,5). Although these research efforts are valuable, they are normally performed under optimal conditions and without pest infestations, conditions that rarely exist in nature.

Nematode damage

Plant-parasite nematodes are root-feeding pests that greatly reduce the development of turf roots. Damage caused by the sting nematode (*Belonolaimus longicaudatus*) (Figure 1) to bermudagrass (*Cynodon* species) root systems can decrease water and nutrient uptake and reduce plant growth (1,3).

Consequently, when nematode damage is present, more water and fertilizer may be necessary to maintain acceptable turf. Hypothetically, the combination of damaged roots and increased fertilization and watering could lead to increased nitrate leaching into the groundwater. To determine whether turfgrass root damage caused by sting nematodes could increase nitrate leaching and reduce nitrogen uptake by the turf plant, we conducted a two-year greenhouse study at the

University of Florida Turfgrass Envirotron in Gainesville.

Methods

We used 40 lysimeters (each 6 inches [15.2 centimeters] in diameter and 18 inches high [45.7 centimeters]) to simulate a putting green soil profile. Tifdwarf bermudagrass was sprigged, topdressed and allowed to grow in, establishing a root system for six weeks (in the first year) and three weeks (in the second year). Following turf establishment, sting nematodes were added to 20 lysimeters (the remaining 20 were untreated), using a completely randomized design (first year) or a randomized complete block design (second year) with five replications each year.

In the first year, 138 nematodes were placed in each lysimeter and allowed time to adjust and reproduce. That year the study began eight weeks after the nematodes were added. In the second year, 300 nematodes were placed in each lysimeter, and the study began three weeks after the nematodes were added. Nitrogen was applied in the form of potassium nitrate fertilizer at 2.25 pounds/1,000 square feet (109 kilograms/hectare) every 21 days at the same rate for the duration of the study.

Root samples for determining root lengths were taken every 42 days after the study began. Root samples consisted of the entire soil profile (6 inches in diameter [15.2 centimeters] and 12 inches [30.5 centimeters] deep) in the first year and a single core (2 inches [5.1 centimeters] in diameter and 12 inches [30.5 centimeters] deep) in the second year. Leaching events were conducted every 21 days (first year) and every 42 days (second year) and the amount of nitrate leached was determined for each lysimeter.

Results

Sting nematodes reduced root lengths by 30%, 42% and 43% at six, 12 and 18 weeks after the beginning of the study during the first year and 50%, 66% and 94% during the second year (Figures 2, 3). By 18 weeks after the beginning of the study, the amount of nitrate leached from lysimeters with sting nematodes was 1.5 to four times greater than that from lysimeters without sting nematodes (Figures 4, 5).

First year

Differences in root growth, nitrogen assimilation and feeding by sting nematodes influenced the way these outcomes were expressed each year. During the first year, actively growing root systems were better established before the nematodes were added, and the nematodes reduced the root systems over time. Early on, these root systems may have been able to compensate for root reduction with increased nitrogen assimilation throughout the remaining root system. However, later in the experiment, as nematodes continued to reduce the root system, they overwhelmed the plant's ability to assimilate nitrogen, which led to the differences observed in leached nitrate.

Second year

Conversely, during the second year, root

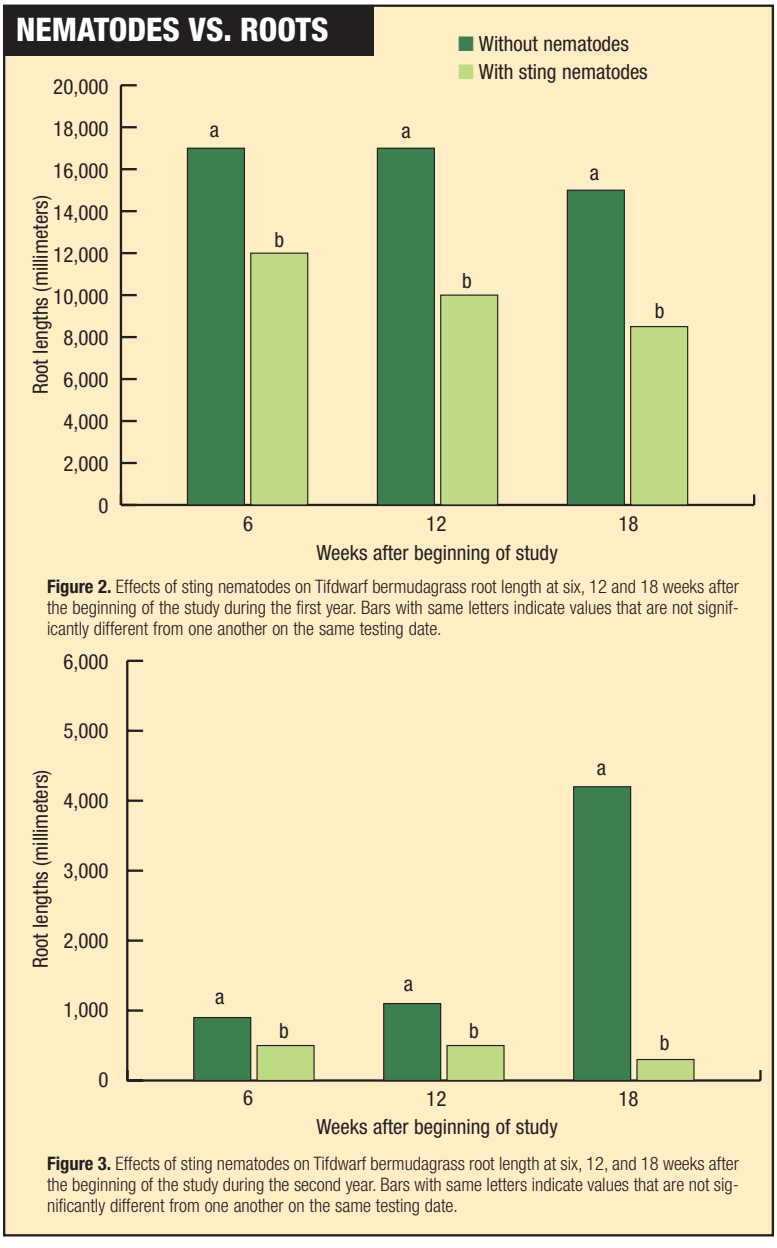

Figure 2. Effects of sting nematodes on Tifdwarf bermudagrass root length at six, 12 and 18 weeks after the beginning of the study during the first year. Bars with same letters indicate values that are not significantly different from one another on the same testing date.

Figure 3. Effects of sting nematodes on Tifdwarf bermudagrass root length at six, 12, and 18 weeks after the beginning of the study during the second year. Bars with same letters indicate values that are not significantly different from one another on the same testing date.

systems were slower to establish and develop because light intensity and duration were limited during winter. As the experiment progressed, light intensity and duration improved, which led to increased root growth and greater nitrogen assimilation in lysimeters without sting nematodes. In the lysimeters with nematodes, their feeding retarded root development.

Nitrate leaching

Differences in nitrate leached may occur sooner in mature stands of turf with older and larger-diameter roots. The older, larger roots are less able to take up water and nutrients from soil, so nitrogen assimilation occurs through root tips, root hairs and finer lateral roots, where nematode feeding typically occurs. Nematode damage to these finer structures then further impairs the plant's ability to take up nitrogen and can lead to greater nitrate leaching.

NEMATODES VS. NITRATE

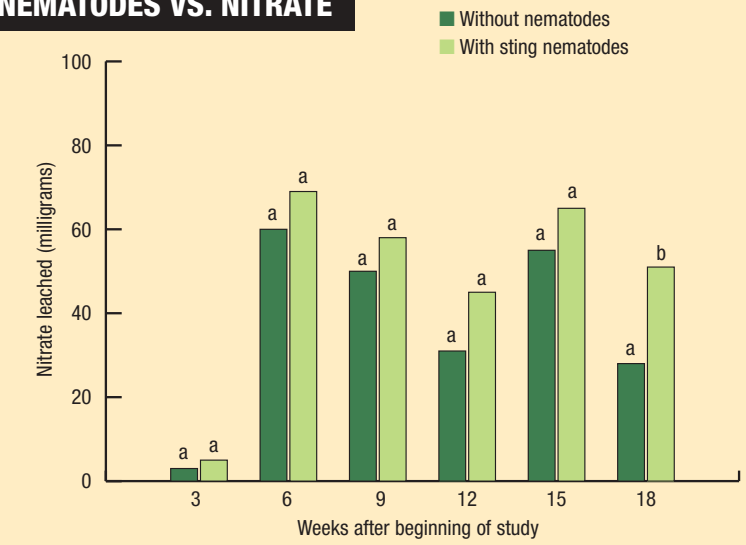

Figure 4. Effects of sting nematodes on milligrams of nitrate leached at three, six, nine, 12, 15 and 18 weeks after the beginning of the study during the first year. Bars with same letters indicate values that are not significantly different from one another on the same testing date.

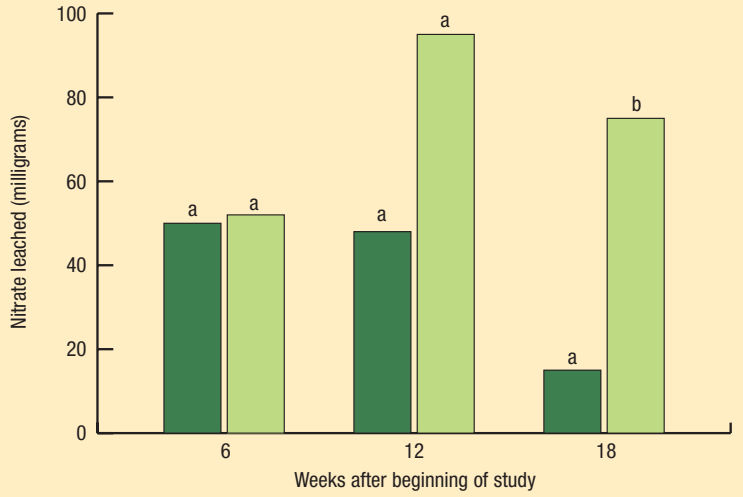

Figure 5. Effects of sting nematodes on milligrams of nitrate leached at six, 12 and 18 weeks after the beginning of the study during the second year. Bars with same letters indicate values that are not significantly different from one another on the same testing date.

Conclusions

Whether turfgrass root systems were established or newly forming, sting nematode damage to the entire turfgrass root system increased nitrate leaching in these experiments. However, the rates of root growth, nitrogen assimilation and feeding by sting nematodes influenced the amount of time needed to observe differences in nitrate leached.

Although it is difficult to extrapolate findings from lysimeters in the greenhouse to field conditions, this experiment does indicate that sting nematodes might contribute to nitrate leaching in some situations. The potential negative environmental impacts resulting from failure to control this destructive turf pest need to be considered as future decisions are made regarding nematicide use on golf courses.

Acknowledgments

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John E. Luc, a former master's of science student in nematology at the University of Florida, is currently a Ph.D. student at Clemson University. William Crow, Ph.D. (wtcr@ifas.ufl.edu), is a nematologist at the University of Florida.