BY JEFF NUS, PH.D

Still Stinging

University of Florida research compares Bermudagrass and seashore paspalum cultivars for their abilities to tolerate nematodes.

"I am often asked by golf course superintendents if a particular cultivar is resistant or has fewer problems with nematodes than other cultivars."

The crucial component of any turf pest control strategy is to use turfgrass cultivars that have the greatest genetic resistance to that pest. After all, if the turf is genetically resistant to certain diseases or insects, there is less dependency on fungicides and insecticides to keep the turf healthy. Can the same strategy be used for nematodes?

That is exactly what University of Florida scientists wanted to know. According to a 2005 field survey of Florida golf courses by Dr. William (Billy) Crow, associate professor of nematology at the University of Florida, 87% of those courses had potentially damaging levels of plant-parasitic nematodes (1). With the loss of Nemacur (fenamiphos) in 2007, questions regarding nematode resistance in turfgrass cultivars are more important than ever.

With funding from the USGA Turfgrass and Environmental Research Program, Dr. Crow and his colleagues, Dr. Kevin Kenworthy (assistant professor

Plots of both Bermudagrass and seashore paspalum were planted in 2008 at University of Florida turfgrass research plots. Nematode counts were taken from soil samples at the time of planting and every 90 days during the growing seasons of 2009 and 2010.

of plant breeding) and graduate student Wenjing Pang, initiated studies to evaluate Bermudagrass and seashore paspalum cultivars for their abilities to resist nematode infestations (2, 3, 4, 5). "I am often asked by golf course superintendents if a particular cultivar is resistant or has fewer problems with nematodes than other cultivars," explains Dr. Crow. "I really wanted to have some research results to answer those types of questions. Use of plant resistance and tolerance is the most long-lasting and environmentally friendly method for controlling pests."

In May 2008 and April 2009 through 2010, two field studies were conducted. Nematode populations in each plot were recorded on the same day the plots were planted. Soil samples were collected every 90 days after planting, and turfgrass health was determined by evaluating root lengths and turf density every three months throughout the growing season (2, 3, 4, 5). Results of the studies showed that the change in sting nematode populations on Bermudagrass plots depended on the cultivar. Populations of sting nematodes increased in Champion (37%) and Mini Verde (40%), but dropped in Tifgreen (4%), TifEagle (18%), Celebration (27%), Floradwarf (32%), Tifway (33%), and TifSport (93%). However, although TifSport Bermudagrass appeared to be more effective at suppressing the reproduction of sting nematodes in the field, the population of spiral nematodes increased 123-fold in those same TifSport plots (2, 4).

> "Nematode species composition and population density depends on lots of factors, including the content of sand, silt, clay, and organic matter that is present in the soil, depth to the water table, compaction, drainage, and presence or absence of natural enemies." – Dr. William Crow

The study revealed not only differences in nematode populations between Bermudagrass cultivars, but also differences between Bermudagrass and seashore paspalum. Seashore-paspalum was a more desirable host to spiral nematodes than it was for sting nematodes. The population densities of spiral nematodes increased 177-, 106-, and 214-fold, while sting nematodes decreased by 69%, 96%, and 86%, respectively, in the seashore paspalum cultivars Aloha, SeaDwarf, and Sea Isle I within two years (3).

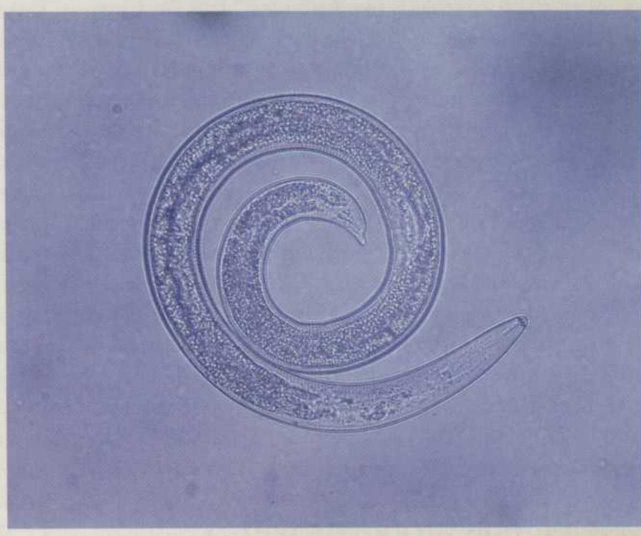
Although seashore paspalum is less affected by sting nematodes, it is more susceptible to damage by spiral nematodes. In other words, choosing seashore-paspalum over Bermudagrass is largely a tradeoff from sting to spiral nematodes. "Both species are damaged by sting nematode, but seashore paspalum has a more vigorous root system that makes it more tolerant than Bermudagrass," says Dr. Crow. "This is why you often see seashore paspalum contaminants outgrowing Bermudagrass in sting nematode-infested areas. However, seashore paspalum is more susceptible to damage from spiral nematodes, which rarely damage Bermudagrass."

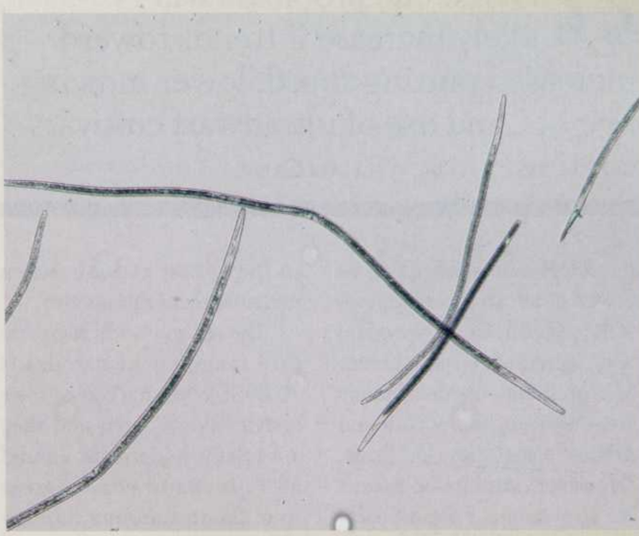
Do these results mean that the dominant species of nematode in a soil sample depends mostly on the turfgrass species (host) that is growing there? Dr. Crow cautions that it is much more complicated than that assumption."Nematode species composition and population density depends on lots of factors, including the content of sand, silt, clay, and organic matter that is present in the soil, depth to the water table, compaction, drainage, and presence or absence of natural enemies. The susceptibility of the host plant is one of the biggest factors involved, but not the only one," says Dr. Crow. "We look at the nematodes from thousands of turfgrass samples each year, so I often can pick up trends, such as seeing greater numbers of a certain type of nematode on a particular cultivar. This research gave me the opportunity to confirm some of these observations."

The results seem to suggest that where several nematode species are present, the presence of one nematode species may inhibit the population growth of other nematode species. If so, is there evidence that this is more than a competitive effect for susceptible hosts? "Yes, we noticed that as sting nematodes increased, spiral nematodes decreased, and vice versa. We have since confirmed this with greenhouse experiments. Interestingly, in our field experiments, spiral nematode numbers got highest on seashore paspalum, whereas sting nematode numbers got highest on Bermudagrass, with the exception of TifSport," explained Dr. Crow. "I suspect that there is more going on than just competitive effects. This is something I hope to do further research on."

Dr. Crow is quick to emphasize that none of the tested Bermudagrass or seashore paspalum cultivars were truly resistant. "Nematologists define a resistant plant as one that the nematode cannot reproduce ón. Based on that, we did not identify any true resistance in commercial cultivars because the nematodes were able to reproduce on all of them. What we did identify was tolerance – cultivars that could deal with nematode feeding better than others," said Dr. Crow.

"Based on our results, for fairways and tee boxes infested with sting nematodes, switching from Tifway to Celebration or TifSport would likely reduce the amount of nematode damage. I know of golf courses in Florida that have made this switch and have been able to reduce greatly the frequency of nematicide applications. On greens, we found that all the ultradwarfs evaluated suffered





University of Florida field studies showed that sting nematodes (top and bottom images) were much more prevalent in plots of Bermudagrass cultivars (with the exception of TifSport), while spiral nematodes (middle image) were found in much higher numbers on seashore paspalum cultivars.

more nematode damage than the dwarfs did. If sting nematodes are a major concern, this should be considered in the decision of what cultivar of Bermudagrass to use."

Dr. Crow also notes that the visual damage by nematodes is more prevalent as more stress is placed on the turf and the golf course industry expands its use of ultradwarf Bermudagrasses. "Nematode problems will likely increase if trends toward increased putting speed, lower mowing heights, and use of ultradwarf cultivars continue. This puts more stress on the turf and makes the turf less tolerant to nematodes. Similarly, the increased use of ultradwarf Bermudagrasses in my region has increased nematode problems."

Although nematodes are extensive on Florida golf courses, Dr. Crow explains the damage to golf course turf is certainly not restricted to the sandy soils of the Sunshine State. "In general, the further north a course is located, the less likely nematode problems will develop, because there will be fewer generations of nematodes per year. On fairways and tees, nematodes will seldom be a problem outside of sandy areas adjacent to the Gulf and Atlantic coasts," says Dr. Crow. "However, sand-based greens are ideal habitat for most parasitic nematodes, wherever they are located. Sting nematodes are being spread by human activity and are now a problem on greens in Texas, Tennessee, Kansas, and California. In the United Kingdom, the root-knot nematode was not a problem until they started using sand-based construction."

In addition to using cultivars that are more tolerant of nematodes, other management practices can tip the scales toward or away from nematode damage. "In Florida, we have found that overseeding doubles the nematode populations on Bermudagrass in the spring. Raising mowing heights and anything else that reduces turf stress will improve tolerance to nematodes," says Dr. Crow. "Good turf maintenance practices, like aerating, that promote root health and the use of soil amendments that increase the soil's nutrient-supplying and water retention capabilities can help turf tolerate the negative effects of nematodes."

Dr. Crow emphasizes the effect that soil temperature has on nematode activity. Although nematode damage will most often be visible during hot, stressful months, nematode damage to turfgrass roots occurs mostly in the spring and fall, when nematodes are most active.

"The optimum soil temperature range for nematodes is 70-80°F. When it is cooler, their activity slows down and they are relatively dormant around 55°F. In warm coastal areas from South Carolina through Texas, it stays warm enough for these nematodes to stay active throughout most of the winter. High soil temperatures (over 90°F) will kill them, so they will move deeper in the soil where it is cooler during high summer temperatures. The root reductions caused by these nematodes generally occur during the spring or fall, while the above-ground damage may not be seen until the summer, when the turf is under the most stress. I recommend sampling early, while the turf is actively growing, and treating if needed at that time. Be proactive — it is much better to treat early and avoid nematode damage than to try to fix a problem."

Finally, Dr. Crow notes that there are new chemistries being developed for nematode control, however it is still important to have a multiple-control strategy. "I am currently working with several new active ingredients, some of which are promising. There is a strong possibility that there will be at least one new nematicide coming out in a couple of years, with more to follow."

Is development of resistance to nematicides something that superintendents should anticipate? "With older chemistries like fenamiphos (Nemacur) and 1, 3-dichloropropene (Curfew), this has not been documented as a problem. What does happen is that with repeated applications, populations of microbes build that rapidly break down the chemical so that it does not get a chance to work properly. This is called 'enhanced microbial degradation' and was a very common problem with Nemacur," notes Dr. Crow.

"This could also become a problem with biopesticides and new chemicals, and it is something I will watch for. Many of the newer chemistries have more intricate modes of action, targeting specific pathways in the target pest. These tend to have more resistance problems than older chemistries, so chemical resistance could become more of a problem in the future. This is why it is critical to have multiple control strategies to rely on, including the right choice of turfgrass." **GCI**

Jeff Nuss, Ph.D., research manager, USGA Green Section

> "Nematode problems will likely increase if trends toward increased putting speed, lower mowing heights, and use of ultradwarf cultivars continue. – Dr. William Crow

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BY JAMES A. MURPHY

The Size of Topdressing Sand

Does it matter?

Superintendents welcome techniques that improve the efficiency of operations on the golf course. The incorporation of topdressing sand into a turfgrass canopy is one of those practices where a gain in efficiency is beneficial. Significant time and other resources can be spent on managing the sand particles left on the putting surface after most of the topdressing is incorporated. These remnant particles are typically large (fine gravel, very coarse, or coarse particles, depending on the quality of the sand) and interfere with mowing and potentially play, if not removed. Blowers can be used to remove these particles, but at the cost of more labor and fuel. Daily mowing eventually removes these large particles, but at the cost of increased mower maintenance through more frequent sharpening and replacement of bedknives and reels.

The incorporation of topdressing sand is more difficult on turf maintained at lower mowing heights and with plant growth regulation that increases shoot density, calculated as the number of turfgrass shoots per square inch. Additionally, newer cultivars developed for putting greens have much greater shoot density compared to older cultivars. Topdressing sand increases the firmness of a putting green surface due to the "bridging" of sand particles within the turf canopy and layer of mat or thatch. However, the bridging among sand particles and with plant material also contributes to the difficulty of incorporating sand.

Techniques to improve the incorporation of topdressing sand include:

- Using dry sand.
- Drying the putting surface before applying the topdressing.
- Verticutting or grooming the putting surface before applying the topdressing.
- Applying the topdressing more frequently at lower application rates.
- Using a sand with fewer large particles.

A significant amount of time and resources is spent on managing the sand particles that remain on the putting surface after topdressing is incorporated.

Movement of sand particles into the turf canopy and mat of a putting surface is inhibited by moisture, regardless of whether the water is within the sand or turf itself. Water acts like glue causing the sand particles to stick to each other (bridge) and to the leaves (and other parts) of the grass plants as well. This bridging effect impedes the movement of sand deep into the turf. Practices such as grooming and verticutting are done to open the turf canopy and reduce the amount of bridging, allowing more of the sand particles to fall deeper into the turf canopy and thatch. Topdress-

Summary Points

• Sand topdressing, regardless of sand size, has yet to provide consistent effects on surface firmness or volumetric water content in either trial. More differences may emerge as cumulative amounts of sand topdressing increase throughout subsequent years of these trials. A drum roller equipped with golf shoe spikes is being designed and constructed to simulate foot traffic on these plots in 2012. Surface firmness across treatments may become more apparent once traffic is implemented.

• On velvet bentgrass turf, topdressing sand applied every two weeks, particularly at 100 pounds per 1,000 square feet, provided better turf quality compared to the non-topdressed plots. With repeated treatment, plots topdressed with medium fine sand eventually had better turf quality than plots topdressed with medium-coarse sand.

• Regardless of sand size, topdressing annual bluegrass every two weeks improved turf quality compared to the non-topdressed plots. In addition, anthracnose disease symptoms were less severe in all topdressed plots by late summer.

• To date, we have not observed any negative effects of topdressing with finer sand on either velvet bentgrass or annual bluegrass maintained as putting green turf. Please note that the finer sands being used in these trials were dominated by medium sand with less than three percent very fine sand content and essentially no silt or clay content. We will continue these topdressing treatments and observations during 2012.

Many superintendents have adopted programs using one sand to fill aeration holes and a finer sand to topdress the surfaces.

Research has shown that frequent applications of topdressing help to manage disease issues.

ing at lower rates also serves to reduce the bridging of sand particles because particles are not as close together, thus improving incorporation. It is essential, however, that lower rates of topdressing be applied more frequently to achieve the same total rate of topdressing, otherwise the objective for topdressing will not be realized.

Many have adopted the strategy of selecting sand that contains no fine gravel (2 to 3.4 mm particle size diameter) or very coarse sand (1 to 2 mm) to improve incorporation of topdressing. More recently, some are selecting sands that do not contain coarse sand (0.5 to 1 mm), which further improves the ability to incorporate the topdressing, especially when it is dry. While these "cleaner" sands greatly improve incorporation, there is concern that sand less than 0.5 mm in size has the potential to negatively change the physical properties of the developing mat (thatch) layer of a putting green.

POTENTIAL ISSUES. Eliminating the larger particles results in more of the particles being similar in size, and this is referred to as poorly or uniformly graded. Uniformly graded sands are more susceptible to instability problems, meaning that the sand particles may shift under traffic. Additionally, finer sand can retain more water and slow its movement. The extent to which these concerns are actually a problem in the context of topdressing is not fully understood. For example, some finer sands, despite being uniformly graded, can pack together and be more stable than coarser sand. Moreover, what we know about the behavior of sands is typically drawn from studies of sand-based rootzones rather than topdressing sand applied to an accumulating mat (thatch) layer.

In an attempt to offset any potential negative impacts of finer topdressing sand, some superintendents are using two sand sizes. This approach uses a coarser sand for the backfill after core aeration, and a finer sand is used for surface topdressing applications. Thus, the concept is to manage any potentially negative effects by coring out the mat layer containing finer sand and replacing it with coarse sand backfill. It is not clear whether this "dual sand" concept will be sufficient to offset any negative effects of the finer sand, presuming that negative effects actually occur.

RESEARCH AT RUTGERS. Two research trials were recently initiated at Rutgers University to evaluate the effects of topdressing sand varying in particle size distribution on turfgrass quality and surface firmness. Our trials compare the use of coarse medium and medium-fine sands on turfs with different thatching tendencies.

Our first field trial was initiated in


The goals of a topdressing program are to manage the organic debris.

2010 on Greenwich velvet bentgrass putting green turf, which has a great thatching tendency. The plots were mowed daily at 0.11 inch with a triplex mower. Irrigation was applied to these plots but only enough to relieve the initial signs of wilt stress, which serves as the indicator to apply water. Either coarse-medium or medium-fine sand was applied every two weeks at 50 or 100 pounds per 1,000 square feet. The plots were evaluated for turf quality, turf color, sand presence, digital image analysis, post-topdressing clipping collection, volumetric water content (0- to 1.5-inch depth), and surface hardness (Clegg Impact Soil Tester [2.25 and 0.5 kg] and USGA TruFirm).

Substantial differences in firmness or quality were not apparent during 2010; however, all topdressing treatments displayed better turfgrass quality than the non-topdressed check plots by early June 2011. By the end of June 2011, a topdressing rate effect was observed. Plots topdressed at 100 pounds per 1,000 square feet had better turfgrass quality than plots topdressed at 50 pounds per 1,000 square feet. Additionally, the medium fine sand started to produce better turf quality than the coarse-medium sand during 2011. It was also becoming more evident as the study continued that topdressing sand needed to be applied at the rate of 100 pounds per 1,000 square feet to observe differences between these two sand sizes.

The amount of sand left on the turf surface after topdressing events was different among the sands. As expected, it took more time for the turf surface to become clear of sand when topdressing was done with the coarse medium sand topdressing or at the rate of 100 pounds per 1,000 square feet. Additionally, the amount of sand harvested during mowing was affected the sand was reduced, less sand was removed by mowing. The critical issue that must be evaluated is, will the use of a finer topdressing sand applied over coarser-textured soils have any long-term ramifications? Will infiltration be affected negatively, and/or will free drainage within the profile be unaffected? These issues will be evaluated as research continues.

A second field trial was initiated in late June 2011 on annual bluegrass putting green turf. Three sand sizes are being used in this trial: a medium coarse sand, a medium sand (the medium-coarse sand sieved to remove coarse sand with a #35 sieve, 500-μm screen), and a medium-fine sand. Topdressing was applied at 50 pounds per 1,000 square feet every 14 days during the summer months. Data collection in this trial was similar to the velvet bentgrass trial. Additionally, anthracnose severity was evaluated every seven to 10 days.

All topdressing treatments had as good or better turfgrass quality than the non-topdressed plots. As expected, more anthracnose disease was observed on the non-topdressed plots compared to all of the plots receiving topdressing sand. No differences among sand sizes were observed in the first year of this trial. **GCI**

(**MORGAHAN** *continued from page 12*)

putting greens might be mown three times a week – if I'm lucky.

I wish someone would hold up a "Quiet Please" sign when I was getting ready to swing. Every hiccup drives the pros crazy, to say nothing of planes flying overhead (or even more ridiculous, the blimp!), the ring of a cell phone (owned by a spectator, who has paid for the opportunity of getting in to watch the tournament), the click of a camera in the hands of a fan.

At a recent LPGA event, a lone spectator was walking behind the green 85 yards away, totally flustering the player, causing her to back off her shot and start her four-minute pre-swing routine all over again. Can you imagine her in my group? She'd have to put up with me and my partners passing wind (on purpose), gabbing on the cell phone, and the squeal of cart breaks three feet from the tee. I get that I'm not playing for a million dollars, but come on…

I guess one privilege of being really, really good is that you don't have to deal with everyday annoyances and inconsistencies. But really: Aren't they part of the challenge and the fun?

Before superintendents and the rest of management go crazy trying to replicate the perfect golf experience for Mr. and Mrs. Average Golfer, they should think about expectations. Do I want the perfect triangle stack of Pro-V1s, my name on a range sign, and ropes separating me from the riff-raff? Sure. But do I expect it? Do I need it? Am I willing to pay for it? No. And will it truly improve the experience? Not enough to make it worth anyone's while to provide it. Not in this economy.

Superintendents, in particular, should not put so much pressure on themselves, and their crews to create superhuman conditions. There are acceptable limits, levels of quality that will make us more than happy. Most people playing on most courses not only aren't elite golfers, they would not know what to do if they did encounter perfect. It would probably make them too nervous to take a divot.

I'm not saying "real" courses – public and private – should abandon their standards and dumb-down their service and conditioning. But they should be realistic about their audience and their budgets. Spend where it makes sense, provide the best possible experience, do the most they can to move people around and let them have fun. We're not playing "perfect" and should not expect to.

As a very accomplished PGA Tour player once told me as I was fuming over a poorly hit shot, "Tim, you're not good enough to get mad!" **GCI**