TURFGRASS TRENDS

PEST CONTROL

Some Nematodes at Root of All Evil

By William T. Crow

Yellow blotches on the greens. Weedy fairways. Poor transition. Decline during the summer. Grass on the athletic field tearing up during the big game. Large areas of (God forbid!) dying grass. All these are symptoms that can be caused by plant-parasitic nematodes.

While nematode problems are especially prevalent in the South, they can occur anywhere and are often misdiagnosed. Some of the questions that I'm frequently asked are: What are nematodes anyway? How do I know if nematodes are a problem? Where do they come from? What can I do about them?

Here are some answers to these common questions:

Raising mowing height, decreasing shade, increasing aeration and reducing traffic can improve nematode tolerance dramatically.

What are nematodes?

Nematodes are unsegmented roundworms that live in soil and water all over the earth. Most nematodes are beneficial, feeding on bacteria and fungi, some are even used as biological control agents on turfgrass insect pests like grubs and mole-crickets. However, there are also nematodes that feed on and damage plants; these are called plant-parasitic nematodes.

Several genera of plant-parasitic nematodes are pests of turfgrasses. Most of the plant-parasitic nematodes that damage turfgrasses feed on roots, although there is one species that feeds on the crown tissue of bentgrass and bluegrass in parts of California. The root-feeding nematodes can be grouped into ectoparasites that remain in the soil and feed on roots from the outside and endoparasites that enter into roots to feed and reproduce.

FIGURE 1

Roots fed upon by sting nematode (left) are abbreviated and stubby compared to healthy roots (right).

Some of the common ectoparasites that damage turfgrasses are sting, stunt, ring, stubby-root and spiral nematodes. Endoparasites that damage turf include root-knot, cyst and root-gall nematodes. Lance nematode is one of the most common plant-parasitic

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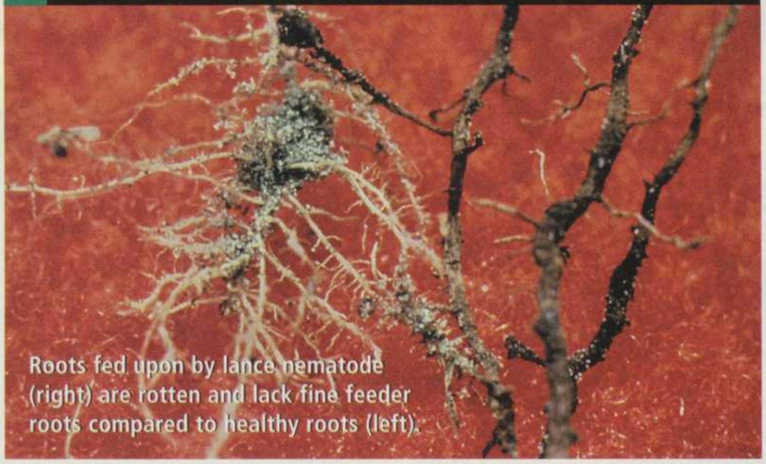
FIGURE 2



Roots fed upon by lance nematode (right) are rotten and lack fine feeder roots compared to healthy roots (left).

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nematodes on turf throughout the United States and can feed both as an endoparasite and an ectoparasite.

Ectoparasitic nematodes typically cause root tips to stop growing and develop an abbreviated or "stubby" appearance (Figure 1). Endoparasites may cause galls or swellings on roots, or rotting and lack of fine-root development (Figure 2). Heavy infestations can lead to an extremely shallow root system that may appear "cropped off" just below the soil surface. Nematode damage to the root system means that the grass cannot obtain the water and nutrients needed for adequate growth. Above-ground symptoms that may develop are yellowing, wilting and decline of the turf accompanied by proliferation of weeds. With severe infestation, death of the turf can occur (Figure 3).

One of the reasons that nematode problems are often misdiagnosed is that plant-parasitic nematodes are microscopic and cannot be seen with the naked eye. Also, the above-ground and below-ground symptoms of nematode damage often resemble those caused by fungal diseases, root-feeding insects or even herbicide damage. Therefore, if nematode problems are suspected, it is important to have a nematode assay conducted by a credible nematode diagnostic lab.

Usually nematode assays are a separate procedure and are not part of a standard plant disease diagnosis, and many plant disease labs cannot perform nematode assays. Fungi such as *Curvularia* and *Pythium* feed on damaged root tissue, so disease samples submitted from nematode-damaged roots often will show these or other fungi present. If the turf does not respond to fungicide treatments, it may be time to take a nematode assay. Nematode samples are collected and handled differently than disease samples, so make sure and contact the lab for instructions before submitting a sample.

Where do they come from?

Nematodes do not fly or migrate on their own from one area to another. A plant-parasitic nematode typically moves just a few inches during its lifetime.

The major ways that nematodes are spread are contaminated soil and planting material. Infested sod and sprigs can be a ready source of nematode inoculum to new areas. For example, sting nematode can only survive in sandy soil, but they can be found infesting sand-based putting greens in areas where the native soil is clay. These nematodes are brought in on sprigs grown in sandy areas and then do fine in the sandy greens.

Nematodes also can be moved in soil adhering to equipment. For this reason aerification equipment should be thoroughly cleaned before

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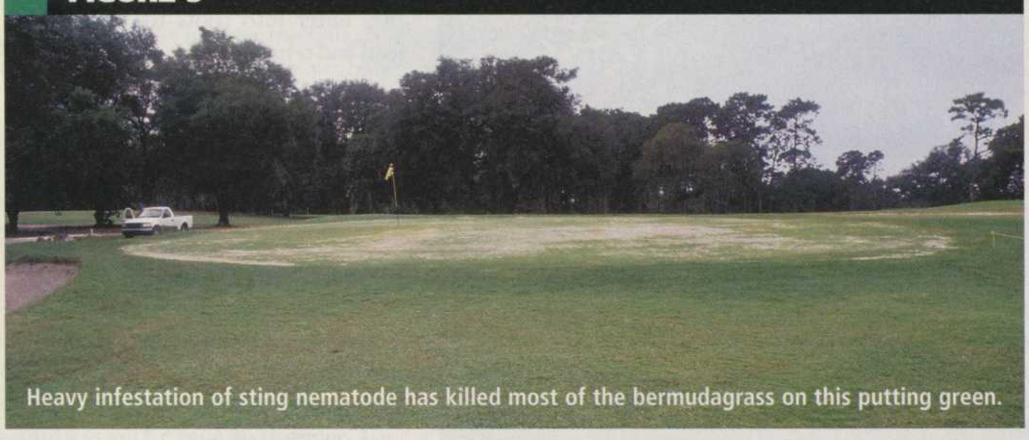
FIGURE 3



Heavy infestation of sting nematode has killed most of the bermudagrass on this putting green.

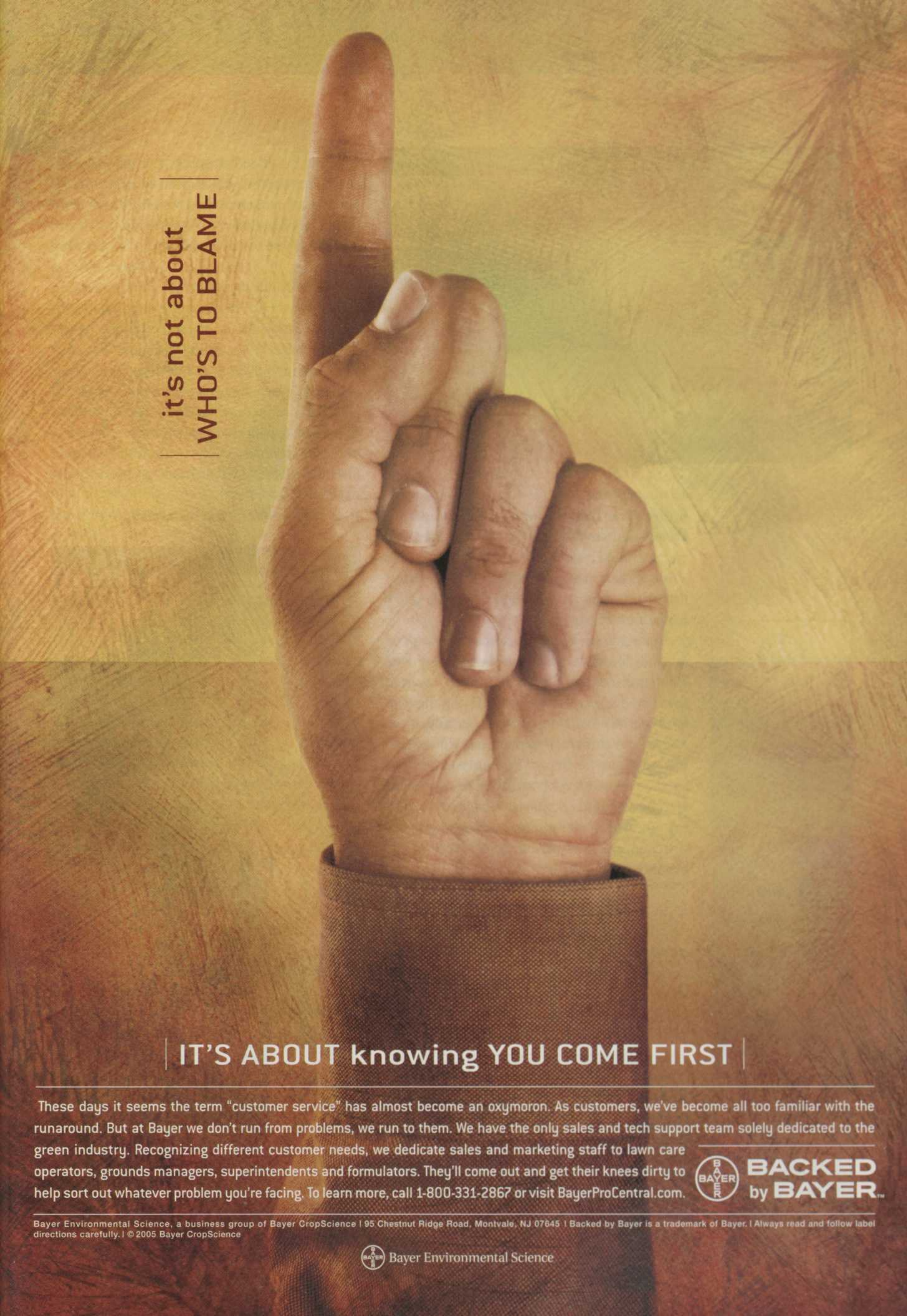


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FIGURE 4

Slit-injection equipment applies soil fumigant on a putting green.

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being moved between locations, and areas with known nematode infestations on a given golf course should be aerified last.

Plant-parasitic nematodes also can occur naturally in an area and then become a problem after turf is planted.

In Florida we have golf courses constructed on sandy locations that used to be orange groves. The sting nematodes that formerly infested these orange groves now are enjoying the new food source provided to them ... bermudagrass. Sometimes nematode populations will exist at low numbers for many years until conditions become favorable for population development and the nematode populations build to damaging numbers. During construction and reconstruction, areas may be fumigated with methyl bromide to kill off the old grass and any soil borne pests like nematodes.

Be aware the fumigation seldom kills 100 percent of the nematodes, and the few survivors can reproduce and still be a problem later.

How to manage problems?

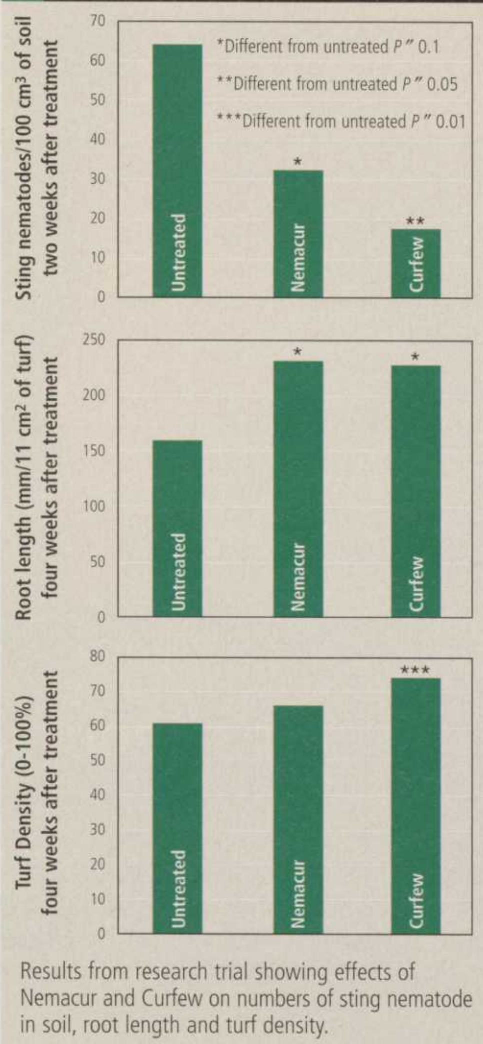
Often nematodes are one of many factors affecting the overall health of turf. In some cases, reducing or eliminating other stresses can help the turf tolerate the negative impacts of the nematodes.

Raising mowing height can improve nematode tolerance dramatically. Decreasing shade, increasing aeration and reducing traffic are other examples of cultural practices that can help improve nematode tolerance in turf.

Nemacur has been the most effective and commonly used nematicide on turfgrasses for the past 25 or 30 years. Because Nemacur is a systemic, it is effective against both ectoparasitic and endoparasitic nematodes. Nemacur causes paralysis of nematodes and prevents them from feeding for a period of time, allowing the turf to put out new roots. Usually there is not a big reduction in nematode numbers after a Nemacur application (sometimes numbers in soil may even increase), so the effectiveness of the application should rather be gauged by the turf response. When the Nemacur is working, turf health should improve. Repeat applications of Nemacur over time have been shown to build up soil microbes that "eat" the active ingredient (fenamiphos) and reduce its efficacy. This has become a common occurrence on golf courses in Florida, where Nemacur has been used extensively over the years.

Due to environmental concerns, Nemacur

FIGURE 12



Results from research trial showing effects of Nemacur and Curfew on numbers of sting nematode in soil, root length and turf density.

will no longer be manufactured after May 2007. Additionally, as of May 2005, Nemacur use is now prohibited on certain soil types. See the Bayer Procentral Web site *www.bayerprocentral.com* to find out if Nemacur can be used at your location.

Curfew Soil Fumigant is presently labeled for nematode control on turfgrasses in Florida, Georgia, North Carolina, South Carolina, Alabama and Mississippi. Additional states may be added later pending state approval and sufficient demand. Curfew Soil Fumigant is slit-injected as a liquid 5 inches to 6 inches deep and then disperses through the soil as a gas, killing nematodes on contact. Because of the specialized injection equipment required (Figure 4) and toxic nature of Curfew, it is only applied by Dow AgroSciences-approved custom applicators. Our research at the University of Florida has shown Curfew to be very effective against plant-parasitic nematodes, particularly ectoparasitic species and also some other turfgrass pests such as molecrickets. For information regarding use and availability of Curfew Soil Fumigant in your area, contact your Dow AgroSciences representative.

Research conducted by researchers in Ohio and Virginia indicates that application of entomopathogenic nematodes (the nematodes used to control insects) may help suppress plant-parasitic nematodes on turf. However, a body of research conducted in Florida found that this tactic was not effective in that state. While research results are inconsistent, this might be something that turfgrass managers attempting a pesticide-alternative approach might want to consider. However, it would not hurt to have a back-up plan in case the results are not as good as desired.

There are numerous products being marketed as "nematicide alternatives" for use on turfgrasses at this time. Many of these are botanical or microbial in origin.

Be aware that many of these products have not been evaluated in objective field trials, or have been evaluated and found to be ineffective. Some turfgrass managers with large budgets prefer to try many of these to see what kind of results they get. I'm glad they are able to do this, because I get a lot of great ideas from these guys. However, for those of you on a shoestring budget, I encourage you to ask for the results from independent field testing before making an expensive purchase. It is very important that the comparisons in these trials be made to untreated control plots and not just use before-and-after nematode counts from treated plots.

FIGURE 5

Before-and-after counts can be very misleading as nematode populations can go up and down naturally over the course of a few months.

Presently we are working with some new botanical and microbial products that show potential as nematode management tactics on turf (Figure 5).

Additionally, some of the chemical companies are seeking new nematicides that will be effective but safer than some of the older nematicides. We also are attempting to identify nematode-resistant and -tolerant turfgrass cultivars. Hopefully these efforts will bear fruit in new nematode management strategies in the near future.

William T. Crow is the landscape nematologist at the University of Florida. He supervises the Florida Nematode Assay Lab, a nematode diagnostic lab specializing in diagnosis of nematode problems on turfgrasses. His research focus is developing improved ways to diagnose and manage nematode problems on turfgrasses and ornamental plants. Crow teaches two graduate courses, nematode diagnostics and field plant nematology.

To see additional figures and photographs with this story, please visit:

www.turfgrasstrends.com

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If It's Winter, It Must Be Time to Put On a Coat (of Green Paint)

By Steven H. Long, H. Liu, L.B. McCarty, and J. A. Thackston

Photograph 1. A pneumatic paint gun is used to apply paint in second direction of first season application.

Painting of greens has recently become the No. 1 alternative to overseeding greens for winter color.

Bermudagrass (*Cynodon dactylon*) growth stops when nighttime temperatures begin to drop below 60 degrees Fahrenheit (F). This is accompanied by discoloration of the turf when temperatures drop below 50 degrees F (McCarty, 2005) and eventually to full dormancy when frost occurs or as temperatures become lower than freezing. Superintendents in the Southern United States, therefore, often overseed bermudagrass greens to meet golfers' desire to play on green grass during winter and increase profits for their golf courses.

The most common cool-season turfgrasses overseeded into dormant bermudagrass greens are rough bluegrass (*Poa trivilias*) and perennial ryegrass (*Lolium perenne*). When an overseeding season starts, the bermudagrass is often not fully dormant yet and is still competing for water and nutrients.

Overseeding itself is disruptive for the existing bermudagrass turf as verticutting or other physical means of thinning the turf is performed to provide good seed-to-soil contact. Additionally, to provide a quality putting green, high overseeding rates are often used. These high seeding rates plus cooler spring temperatures often weaken the bermudagrass turf and potentially results in catastrophic problems during spring transition into summer.

In severe cases, a golf course will transition from overseeded cool-season turf to severely thinned or even dead bermudagrass turf.

Other problems include increased susceptibility to various diseases and the inability to rid the overseeded grass, which then becomes a lingering noxious weed. In addition to these management problems, cost can become a problem for golf courses as well, which is between $500 and $2,000 per overseeded acre (McCarty, 2005).

Overseeding is viewed by many golf course managers as a necessary high-cost practice to attract and retain winter-play golfers. For all these reasons, turf professionals have sought alternatives to overseeding and discovered a potential one in the simplest of areas, painting.

The alternative

The practice of painting greens is gaining notoriety because of its inexpensiveness, attractiveness, bermudagrass health maintenance and playability.

Rodney Lingle at Memphis Country Club in Tennessee has been successfully painting Champion bermudagrass (*C. dactylon (L.)* Pers. X *C. transvaalensis* Burtt-Davy) putting greens for 15 years (Carson, 2004).

When compared to high costs of overseeding, painting of golf course greens could potentially save a course significant dollars each year to be applied in other areas of required maintenance. Costs of painting greens usually range from about $900 to $3,000 total per season for an 18-hole golf course, depending on number of applications and price of paints (Carson, 2004).

Considering that an average 18-hole course has about three acres of greens, overseeding costs could reach upwards of $6,000 per season, twice as much as painting.

Since the advantages of painting greens can far outweigh the disadvantages, why isn't it more widely practiced?

A main reason may be because of the lack of scientific data demonstrating its effectiveness in a golf course situation. In addition, golfers need to be informed that painted greens are just as playable as overseeded turf. The presented study provides golfers and golf course superintendents with research results on painting golf putting greens.

The study

A two-year replicated field study is in progress at Clemson University to evaluate effects of two painting brands (Titan and Missouri Turf Paint) applied at one and/or two applications per winter season vs. a control with no paint or overseeding.

Overseeding costs can reach upwards of $6,000 per season, twice as much as painting.

Paints were applied pneumatically with a portable air compressor and hand gun (Photograph 1). Paints were mixed at a label-recommended 10:1 ratio (water:paint). Each plot was sprayed in two directions to minimize streaking.

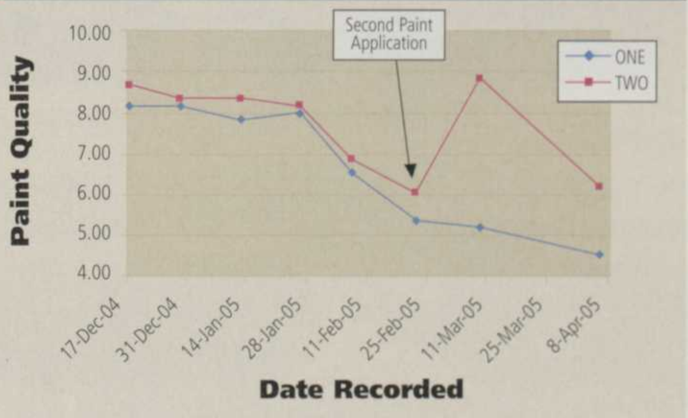
The study was initiated Dec. 13, 2004, on a completely dormant Champion bermudagrass putting green (Photograph 2).

Each paint brand and application rate was replicated three times. The first application of paints took place Dec. 13, 2004, and the second application followed on Feb. 23, 2005. Irrigation was applied as needed along with weekly, heavy foot traffic to obtain more realistic wearing and fading of the turf paints as observed in a golf course situation. Foot traffic was implemented by one person walking over the plot four times in alternating directions with soft-spiked golf shoes. The study will conclude in July 2006 following collection of the second year's spring green-up data.

Parameters measured include paint color quality, ball roll distance, soil temperature, spring green-up and summer turf quality. Visual paint quality (PQ) ratings were taken weekly and include color tone and fading of paints. PQ was measured on a 1 to 9 scale (1=brown turf, 7=acceptable green color, 9=dark green color).

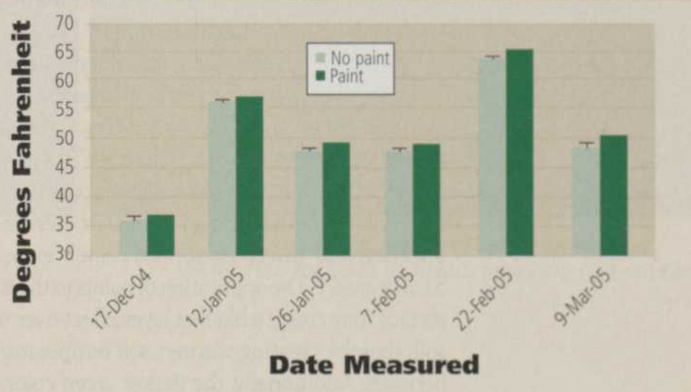
From May through July, visual quality ratings were based on turf quality (TQ) concerning spring green-up and summer turf color. These TQ ratings were taken weekly on a scale of 1 to 9 (1=completely dormant or dead turf, 7=acceptable turf, 9=perfect stand of turf). Ball roll distance was measured biweekly from the December painting until April when spring green-up begins using a standard Stimpmeter.

CHART 1



Paint quality ratings of one vs. two paint applications per season for year 1.

CHART 2



Soil temperatures of painted versus non-painted plots for year 1.

Soil temperatures at a depth of three inches (7.6 centimeters [cm]) were recorded using a digital thermometer throughout the winter months.

Data analysis

All statistical computations are being conducted using analysis of variance (ANOVA) within the Statistical Analysis System (SAS Institute, 1999). Means are being separated by Fisher's Least Significant Difference (LSD) test at an alpha level of 0.05.

Visual PQ ratings from December 2004 through April 2005 are shown in Chart 1.

Two applications per winter season provided significantly higher paint quality rating averages of 7.7 for the season vs. one application, which averaged 6.7. This was expected since

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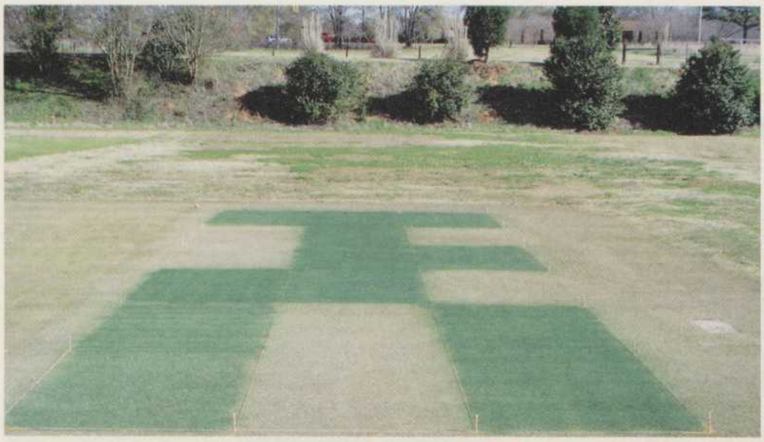

Photograph 2. Finished first season application of paints to study plots.

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paints tend to fade over certain periods because of sunlight and exposure to rain and traffic. A sharp increase in PQ in early March followed the second paint application (Chart 1).

Interestingly, no significant differences in PQ were noted between the two paint brands.

Differences in soil temperatures were also noted between treatments (Chart 2). Turf paints significantly increased soil temperatures during the winter months from an untreated average of 49.9 degrees F to a twice-applied paint average of 51.3 degrees F. The application of paints to the turf surface may create a blanket layer effect over the soil, thereby creating warmer soil temperatures beneath. Additionally, the darker green color of the painted surface vs. the lighter brown color of the untreated surface absorbs more solar radiation to further increase soil temperatures.

It was hypothesized that turf paints would reduce ball roll distance and that roll would be further impeded with repeat applications. However, differences in ball roll distance were not seen between turf paint brands or number of applications in year 1.

Titan Turf Paint and Missouri Turf Paint significantly increased spring green-up TQ of untreated from 4.4 to 5.0 and 5.3, respectively.

Additionally, twice-applied paints with TQ of 5.5 resulted in significantly higher TQ than single applications at 4.9 and untreated at 4.4. This probably resulted from the turf paints increasing soil temperatures. By increasing soil temperatures, paint-treated plots began spring green-up earlier and thereby received a higher average TQ rating.

Shearman et. al. (2005) made similar findings where paint-treated buffalograss (*Buchloe dactyloides*) had earlier spring green-up with painted vs. nontreated buffalograss and this earlier spring green-up positively correlated to soil temperatures created by the application of turf paints.

No differences in TQ occurred between paint brands.

Preliminary conclusions

Following one year of study, we have reached the following conclusions:

- Treatments receiving once- and/or twice-applied turf paints had no negative effect on summer turf performance.
- Differences in PQ, spring green-up, ball roll and soil temperatures were not found in two selected painting brands for this study.
- The twice-applied paint treatment showed improved winter color and spring green-up compared to only painting once.
- Differences were not found in ball roll distance between painted and nonpainted plots.
- Painted treatments significantly increased soil temperatures.
- Painting has greater positive effects and no negative effects on dormant bermudagrass when compared to effects and drawbacks of overseeding.
- Painting is a safe, suitable alternative to overseeding for winter color.

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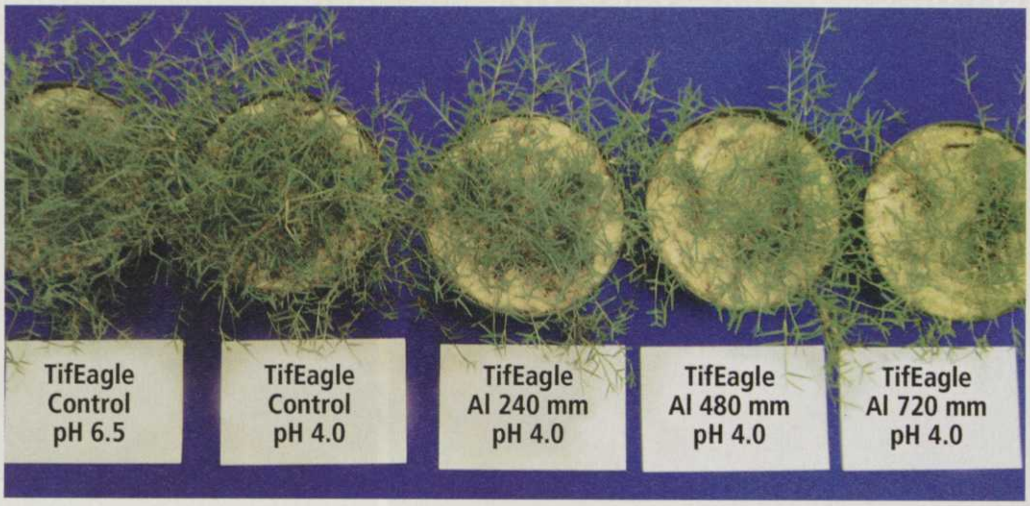
Aluminum Tolerances of 10 Warm-Season Turfgrasses

By Christian M. Baldwin, H. Liu, L.B. McCarty and W.L. Bauerle



Photograph 1. Shoot mass decline of TifEagle bermudagrass in response to 240, 480 and 720 millimeters of aluminum.

Aluminum (Al) toxicity has been studied since it was first identified as a major limiting factor of crop productivity grown in acid soils (Hartwell and Pember, 1918).

Most plants are sensitive to soil Al concentrations, even in micromolars.

Approximately 40 percent of arable land in the world is acidic (Kochian et al., 2004), including Southern and transitional zones of the United States where warm-season turfgrasses are grown. Aluminum toxicity is closely associated with low soil pH (under 5.0), where such soils release Al for uptake and therefore adversely affect plant growth. Generally, all soils contain about 8 percent Al by weight and become toxic only when the soil pH is lower than 5.0.

At low soil pH, soil Al becomes soluble being available for plant uptake. When soil pH is close to neutral or above, soil Al is precipitated and not available for plant uptake. Therefore, raising soil pH by liming is an efficient way to reduce Al toxicity in acid soils.

However, liming agents move slowly through the soil profile, and repeat applications add costs for agricultural production. Also, excessive lime applications may cause a new nutrient imbalance, such as potassium (K) deficiency (Foy et al., 1978).

When exposed to Al, plant growth is negatively affected because Al inhibits plant root tip cell division and cell elongation (Clarkson, 1965). In addition, plants grown in acidic soils experience nutrient imbalances and deficiencies (phosphorus [P], potassium [K], calcium [Ca] and magnesium [Mg]), reduced root and shoot growth (Photograph 1) and reduced stress tolerance (Marschner, 1991).

The effects of Al toxicity on nutrient uptake, especially P and Ca, for cool-season turfgrasses and wheat cultivars have been reported (Foy and Murray, 1998b). In addition, genetic differences in Al tolerance of cool-season turfgrasses have been reported (Liu et al., 1995; Foy and Murray, 1998a).

Research on warm-season turfgrass Al tolerance is limited. However, Liu (2005) reported differences in seeded bermudagrass cultivars to Al tolerance, and Wu et al. (1981) reported different Al tolerances of four vegetative-propagated bermudagrass cultivars. Therefore, the objectives of this study were to determine if genetic differences in Al tolerance existed among selected warm-season turfgrasses and how nutrient concentrations in root and shoot tissue were affected when exposed to micromolar Al concentrations.

Low to moderate Al exposure

Study I consisted of three Al treatments (240 µm, 480 micrometers [µm] and 720 µm) at pH of 4.0

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