TURFGRASS TRENDS

DISEASE CONTROL

CaSi Doesn't Strengthen Creeping Bent, Tall Fescue against Foliar Disease

By Jack Fry, Qi Zhang, Kathy Lowe and Ned Tisserat

Some researchers report that one potential tool for reducing fungicide requirements on turfgrasses may be the use of silicon (Si) fertilizers. Silicon has been reported to suppress diseases on various crops in the last decade (Raid et al., 1992; Chérif et al., 1994; Deren et al., 1994; Seebold et al, 2000; Seebold et al., 2001).

Researchers in North Carolina found that brown patch and dollar spot on creeping bentgrass were reduced approximately 20 percent and 30 percent, respectively, when soluble potassium silicate (21 percent SiO_2) at 0.5 pounds per 1,000 square feet was applied (Uriarte et al., 2004). However, in that study measurable increases in potassium but not Si occurred in creeping bentgrass leaves.

Gray leaf spot on St. Augustinegrass was reduced 9 percent to 28 percent by Si alone (100 pounds per 1,000 square feet) and 59 percent to 68 percent with the com-

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FIGURE 1

Study area after topdressing calcium silicate on the L-93 creeping bentgrass putting green at the Kansas City Country Club in Mission Hills, Kan.

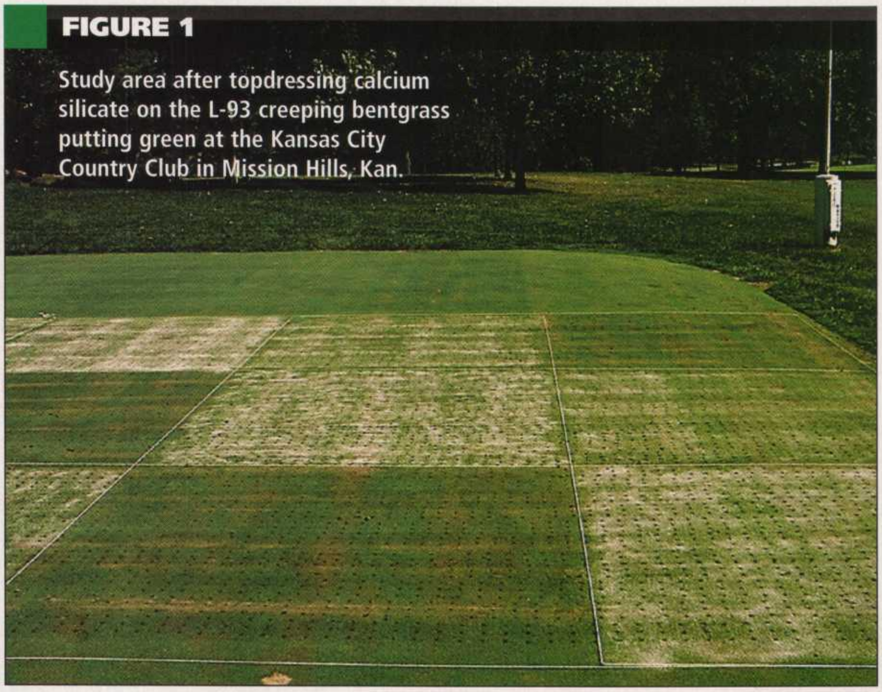

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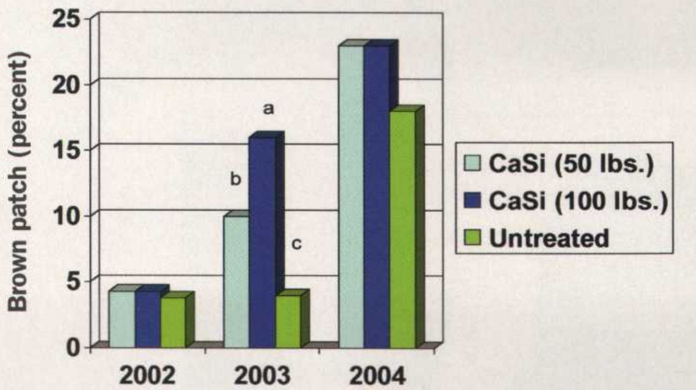
FIGURE 2



Brown patch on L93 creeping bentgrass as affected by calcium silicate at the Kansas City Country Club. Rates indicate amounts applied per 1,000 square feet. Data were collected in August 2002 and 2003 and July 2004. No differences occurred in 2002 or 2004. All treatments were different ($P<0.05$) in 2003.

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bination of Si and the fungicide Daconil (Brecht et al., 2004).

It is believed that Si may reduce foliar diseases by creating a physical barrier to restrict fungal hyphae penetration (Kim et al., 2002). Alternatively, Si may serve to encourage the accumulation of other chemicals in the plant that confer resistance. (Chérif et al., 1992a; Chérif et al., 1992b).

We conducted field experiments to evaluate the potential for calcium silicate ($CaSiO_3$) topdressing to reduce dollar spot on creeping bentgrass and brown patch reduction on creeping bentgrass and tall fescue.

Methods

Creeping Bentgrass: This experiment was conducted on an L-93 creeping bentgrass nursery putting green at the Kansas City Country Club in Mission Hills, Kansas (Fig. 1).

L-93 creeping bentgrass was seeded in March 2002 on a rootzone consisting of 98 percent sand and 2 percent clay. Soil pH was 6.9, and phosphorus (P) and potassium (K) levels were 20 and 25, respectively (Brown, 1998). Soil Si level when tested in untreated plots in 2003 was 2.9 $mg\ kg^{1}$ (milligrams per kilogram, or ppm). Treatments included two levels of $CaSiO_3$ application and untreated turf.

Calcium silicate (31 percent SiO_2, 22 percent calcium [Ca]) was uniformly applied using a hand-held shaker bottle at 50 pounds or 100 pounds per 1,000 square feet on May 24 and Sept. 26, 2002; April 4 and Aug. 15, 2003; and May 4, 2004. Prior to $CaSiO_3$ application, the study area was core aerified.

Nitrogen from a combination of granular and liquid quick-release fertilizers was used throughout each year to provide a total of about 6 pounds of nitrogen (N) per 1,000 square feet. Turf was mowed at 0.118 inches every other day and watered as needed.

Data were collected on turfgrass visual quality, brown patch severity (percentage of brown patch infested area), dollar spot, levels of N, P, K, Ca, Si in leaves and Si levels in soil. Visual quality and brown patch severity were measured once in August in 2002 and 2003 and in July 2004 when the disease was most active in the field.

Tall Fescue: This study was conducted on a 1-year old stand of Tarheel and Bonsai II tall fescue at the Rocky Ford Turfgrass Research Center in Manhattan, Kan. Responses of cultivars to $CaSiO_3$ application were similar and data are averaged over both. Soil was a silt loam and tests indicated a pH of 6.4 and P and K levels of 41 and 367 $mg\ kg^{1}$, respectively, and an initial Si content of 173 $mg\ kg^{-1}$. Turfgrass was mowed at 7.5 cm twice weekly and watered as needed.

Urea (4600) was applied to provide N at 1 pound per 1,000 square feet on April 17, May 3 and Sept. 18, 2002; May 5 and 29 and Sept. 22, 2003.

Calcium silicate was applied at the same rates as in the creeping bentgrass experiment on May 29 and Oct. 10, 2002, and May 14 and Sept. 29, 2003. In addition, a treatment consisting of the fungicide Prostar at 2.2 oz. per 1,000 square feet was applied on 21-day intervals with a CO_2 pressurized sprayer at 30 psi in water equivalent to 87 gallons per acre. The initial Prostar application was made the last week of May in each year and the final application the last week of September.

Data were collected on turfgrass visual quality, leaf N, P, K and Ca concentrations and Si concentration in leaves and soil. Turfgrass visual quality was rated once weekly on a 0 to 9 scale, where 0 = dead turf; 6 = acceptable quality for a home lawn; and 9 = optimum color, density and uniformity. The percentage

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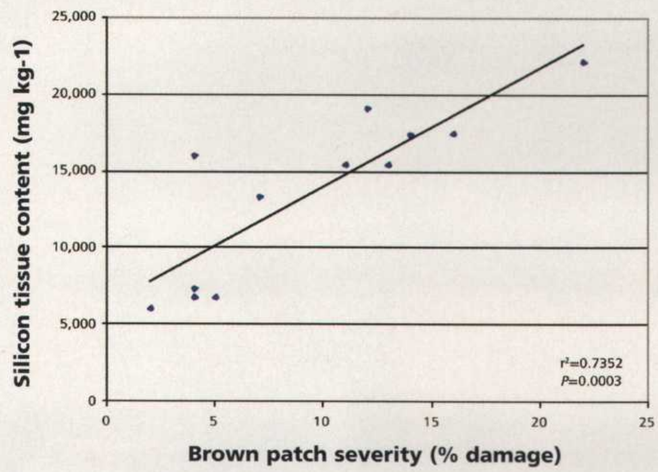
FIGURE 3



Correlation between Si tissue content in L93 creeping bentgrass and brown patch severity in August 2003 in a field experiment at the Kansas City Country Club.

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of each plot infested with brown patch was rated visually each week and analyzed using Area Under the Disease Progress Curve (AUDPC) that allows comparison of treatments using a whole season data summary (Campbell and Madden, 1991).

Leaf nutrient concentration was determined by collecting clippings with a rotary mower on Aug. 2 and Oct. 10, 2002; and May 14, Aug. 20 and Oct. 5, 2003, and using standard laboratory methods. Four soil cores (0.6-inch diameter and three inches deep) were randomly sampled in each plot on the same dates as leaf tissue sampling in 2003.

Results

Creeping Bentgrass: Topdressing creeping bentgrass with $CaSiO_3$ increased soil Si levels on three of four sampling dates over three years and leaf Si levels on each of seven sampling dates over the same period.

Calcium levels in leaves increased on five of seven sampling dates. Brown patch was observed in all three years with the highest pressure observed in untreated plots in 2004, when 23 percent of the plot area was affected. Despite higher soil and leaf Si levels, brown patch severity was not reduced.

In contrast, brown patch increased with $CaSiO_3$ topdressing level in 2003, with 4 percent infection in untreated turf and 23 percent infection in turf receiving $CaSiO_3$ at 50 or 100 pounds per 1,000 square feet (Fig. 2). There was a positive correlation between brown patch severity and Si tissue level on this date (Fig. 3).

Brown patch was not correlated to levels of other nutrient levels measured in leaf tissue, however. A higher percentage of brown patch infection was observed in creeping bentgrass with higher Si tissue contents.

Dollar spot was observed only in July 2004, but there were no differences in the number of infection centers among $CaSiO_3$-treated and untreated turf.

Levels of N, P and K declined in creeping bentgrass leaves as Si tissue levels increased. Nevertheless, levels of all three nutrients were in the sufficiency range throughout the experiment (Waddington, 1989). Turf quality was unacceptable in all three years (quality <5), due mainly to the presence of brown patch.

Tall Fescue: Application of $CaSiO_3$ increased soil levels of Si but raised tall fescue leaf Ca and Si levels on only one of five sampling dates. Only tall fescue treated with Prostar exhibited less brown patch than untreated turf and had acceptable quality throughout both years (Fig. 4).

Tall fescue treated with $CaSiO_3$ at 100 pounds per 1,000 square feet exhibited 23 percent and 26 percent more brown patch than untreated turf in 2002 and 2003, respectively. Tall fescue receiving $CaSiO_3$ at 50 pounds per 1,000 sq. ft. had 30 percent more brown patch than untreated turf in 2003.

We observed that P and K tissue contents were lower in turf treated with $CaSiO_3$ than untreated turf in August, 2002 and 2003, respectively. The consequences of tissue nutrient imbalances created by Si are unknown.

Summary

Initial soil Si levels seemed to play a primary role in whether differences in Si leaf levels were observed. In the tall fescue study, Si soil content in an untreated silt loam soil was 173 mg kg^{-1} and few differences in Si leaf level were observed after $CaSiO_3$ application. In the creeping bentgrass study, initial soil levels were 2.9 mg per kg, and Si leaf accumulation occurred.

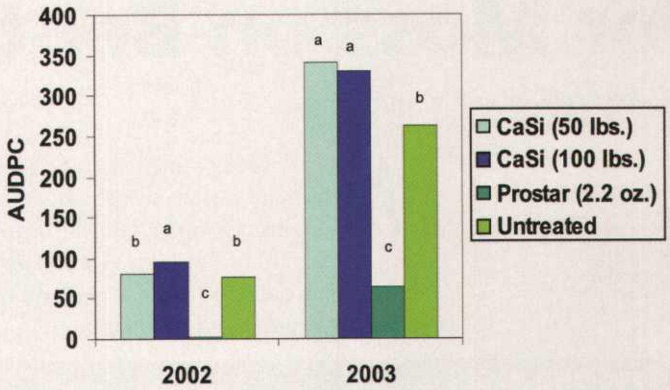
Other researchers reported that soluble Si applications helped to reduce leaf spot in bermudagrass and gray leaf spot in St. Augustinegrass in Si-deficient soil (10 mg per kg) (Datnoff and Rutherford, 2003; Brecht et al., 2004).

However, our results indicate that despite increases in tissue Si levels in creeping bentgrass following $CaSiO_3$ application where soil Si content was relatively low (2.9 mg per kg), brown patch was unaffected in two of three years and more severe in one of three years.

Dollar spot was also unaffected by $CaSiO_3$ application on creeping bentgrass. Tall fescue growing on soil with high (173 mg per kg) initial Si levels had higher brown patch levels in each of two years when topdressed with $CaSiO_3$. As such, we observed no benefit to topdressing tall fescue or creeping bentgrass with $CaSiO_3$ in an effort to reduce brown patch or dollar spot.

The authors are grateful to Loren Breedlove, superintendent at Kansas City Country Club, for allowing us to use a nursery putting green for part of this research.

FIGURE 4



Brown patch in tall fescue (area under the disease progress curve, AUDPC) as affected by two levels of calcium silicate (CaSiO3) and the fungicide Prostar (rates are per 1,000 sq. ft.). Bars labeled with different letters are significantly different (P<0.05).

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Patterns of Disease:
Understanding the nature of dollar spot and its management implications

By Brandon Horvath

Dollar spot is one of our most important but least understood turfgrass diseases. Superintendents spend significant dollars battling the disease and trying to avoid fungicide resistance. Yet for all we know about when the disease occurs and how to control it, we know very little about the biology of this pathogen and how it spreads.

Having a better understanding about the biological processes that affect where dollar spot occurs and how it spreads could ultimately result in the turfgrass manager more effectively managing dollar spot, applying control products only where they are needed and spending less on fungicide applications in the process.

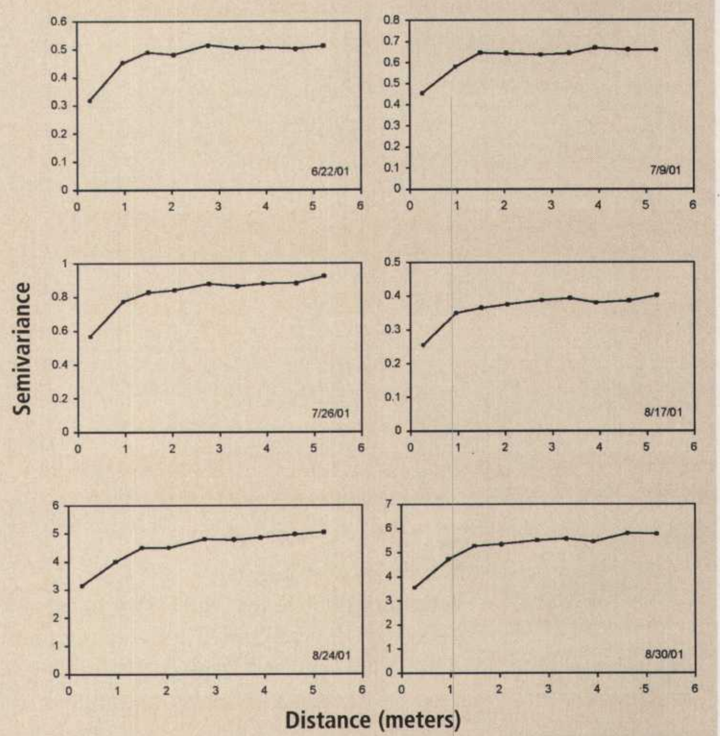
Some of the questions I addressed in my research included: Does dollar spot occur in a pattern? How does that pattern (if it occurs) change over a season? What are the management issues raised by the results? The answers to these questions will lead to a better understanding of this important turfgrass pathogen.

Is there a pattern?

Dollar spot is caused by the fungal pathogen, *Sclerotinia homoeocarpa*. This pathogen infects both cool-season and warm-season grasses and is somewhat unique among the turfgrass pathogens because it is not known to produce spores of any kind. Without spores to move the pathogen around, it is believed that dollar spot moves from place to place via infected plants transported on equipment or on the bottom of our shoes.

So, to answer some of these questions, a research area was established at the Robert Hancock Turfgrass Research Center at Michigan State University in East Lansing. The study area was 30 feet by 60 feet and was comprised of a grid of 200 sampling locations in 2000 and 888 sampling locations in 2001 and 2002.

FIGURE 1A



Variograms of dollar spot epidemic caused by *S. homoeocarpa* on a mixed sward of creeping bentgrass and annual bluegrass on six dates in 2001 selected to be representative of changes in disease progress throughout the growing season.

Dollar spot epidemics were followed each season from 2000-2002, and the number of dollar spots occurring at each of the sampling locations were counted twice per week. Over the course of the study, over 81,000 dollar spots were counted.

Once the number and location of the dollar spots were known, the pattern (or lack thereof) the spots was measured. Statistical tools called geostatistics were used to determine if the dollar spots were occurring in a pattern. These tools were originally developed to

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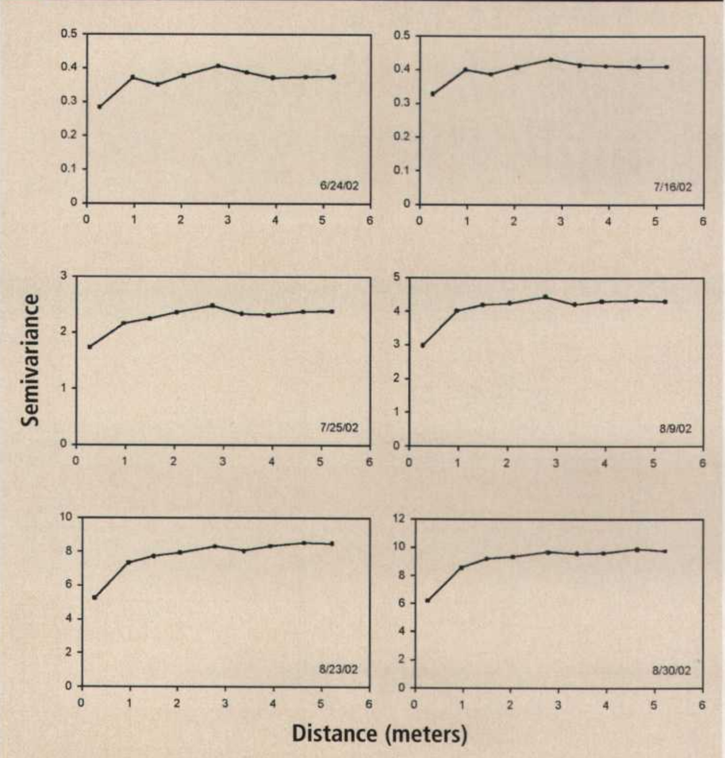
FIGURE 1B



Variograms of dollar spot epidemic caused by *S. homoeocarpa* on a mixed sward of creeping bentgrass and annual bluegrass on six dates in 2002 selected to be representative of changes in disease progress throughout the growing season.

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determine the size and shape of ore bodies and petroleum reserves buried deep underground.

The primary tool, called a variogram, is used to summarize how the trait one measures (in our case, the number of dollar spots) varies with location in space using a measure called semivariance. This value is plotted to graphically show how similar two locations separated by some distance are to each other. Locations separated by shorter distances tend to be more similar and consequently have a smaller semivariance than locations separated by larger distances. If there are differences in semivariance values between locations separated by short vs. longer distances this indicates that the measured value has a spatial pattern. Our semivariance plots showed that dollar spot did occur in a pattern (Figures 1a and 1b).

How does the pattern change?

Over the course of a growing season, the number of dollar spots that occur in an area increases and decreases (Figure 2). Presumably, this is due to environmental conditions that affect the appearance of disease, the growth and vigor of the host plant and the virulence of the pathogen.

If the pattern changed over the course of the season, the expectation would be to observe a similar change in the semivariance plots.

However, the results of this study showed that regardless of how much disease was present, the overall pattern remained stable. (Fig. 1a and Fig. 1b). More interesting was the result that the pattern remained stable over the entire three-year period of the study. This doesn't necessarily mean that dollar spot occurs in the exact same location but rather that whatever pattern begins the season, this pattern remains throughout.

As a result, this indicates that whatever the factors are that affect where dollar spot occurs, they are similarly stable. These results also raise interesting questions about management practices and their impact on spatial pattern.

Management issues raised

The conventional wisdom about the spread and movement of dollar spot is that it moves on infected clippings on equipment and people. Researchers often use this method to inoculate a new area of turf with dollar spot by spreading infected clippings around the area. Since dollar spot isn't known to produce spores, movement via equipment and people seems logical. However, the results of this research do not support this conclusion.

The effect that movement via equipment or through a spore would have on the observed pattern would be a change in the semivariogram plot when movement was taking place.

For example, with regular daily mowing of the study area, if dollar spot was being picked up by the mower and reinoculated downstream, one would expect the spatial pattern to be diluted and more representative of a random pattern as the clusters of dollar spot were spread out from the original foci. It is likely that mowing equipment

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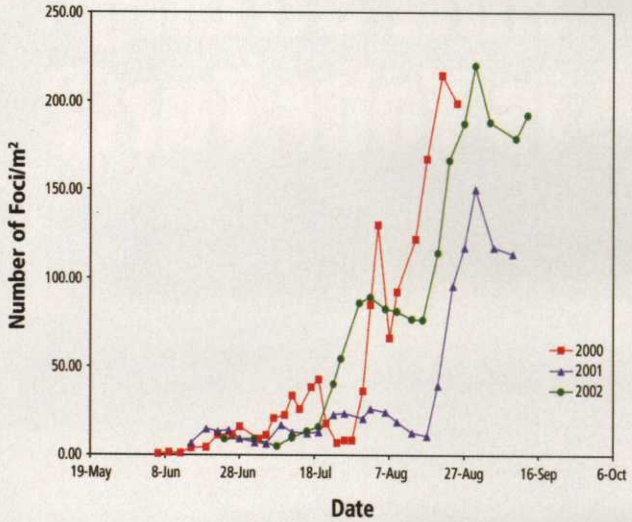
FIGURE 2



Overall disease progress of dollar spot epidemics on a mixed sward of creeping bentgrass and annual bluegrass from 2000 to 2002 as measured by the average number of dollar spot foci m^{-2}.

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and people spread the pathogen to some small degree, but the factor that governs the spatial pattern of dollar spot seems to be as stable our observations of spatial pattern were over the three years of the study.

Based on the results of this study, it seems that mowers are quite efficient in picking up and retaining the tissue that is cut by the mowing unit rather that spreading it downstream. More research is needed to see if dollar spot is moved by mowing equipment and to define the conditions under which movement is possible.

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As we understand more about turfgrass disease biology and spread, management practices can be implemented to improve disease management programs with cultural practices and make chemical applications more efficient and environmentally sensitive. Using these techniques it is possible to develop prediction tools that allow a turfgrass manager to better time chemical applications and can ultimately allow managers to target specific areas of the property in a site-specific manner rather than making the blanket applications that are presently the norm.

Brandon Horvath was recently hired as an assistant professor in the department of plant pathology and weed science at Virginia Polytechnic Institute and State University. He is a turfgrass pathologist at the Hampton Roads Agricultural Research and Extension Center in Virginia Beach, Va.