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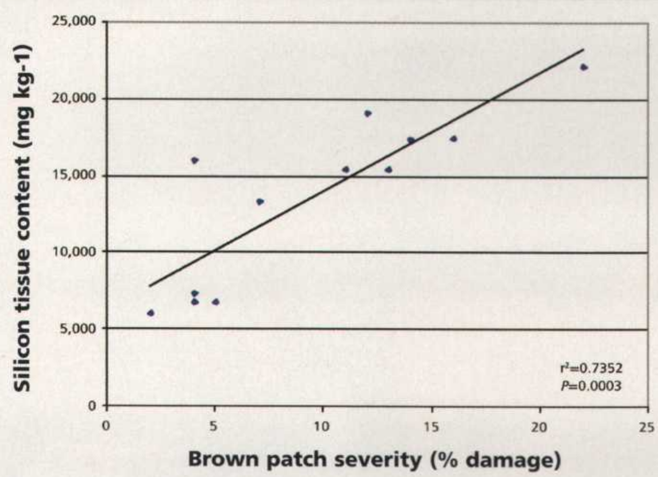
FIGURE 3



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.

Continued from page 60

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.

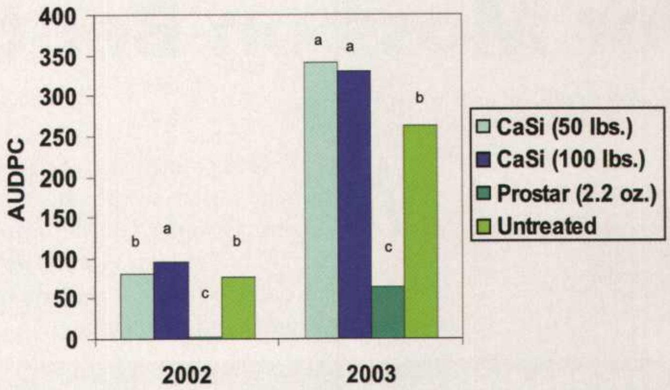
Other researchers reported that soluble Si applications helped to reduce leaf spot in bermudagrass and gray leaf spot in St. Augustinegrass in Si-deficient soil (10 mg per kg) (Datnoff and Rutherford, 2003; Brecht et al., 2004).

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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REFERENCES

Brecht MO, Datnoff LE, Kucharek TA, Nagata RT. 2004. "Influence of silicon and chlorothalonil on the suppression of gray leaf spot and increase plant growth in St. Augustinegrass." *Plant Dis.* 88:338-344.

Campbell CL, Madden LV. 1991. "Introduction to plant disease epidemiology." John Wiley and Sons, New York.

Chérif M, Menzies JG, Benhamou N, Bélanger RR. 1992a. "Studies of silicon distribution in wounded and *Pythium ultimum* infected cucumber plants." *Physiol Mol Plant Pathol.* 41:371-385.

Chérif M, Menzies JG, Benhamou N, Bélanger RR. 1992b. "Silicon induced resistance in cucumber plants against *Pythium ultimum.*" *Physiol Mol Plant Path.* 41:411-425.

Chérif M, Menzies JG, Ehret DL, Bogdanoff C, Bélanger RR. 1994. "Yield of cucumber infected with *Pythium aphanidermatum* when grown with soluble silicon." *HortSci.* 29:896-897.

Datnoff LE and Rutherford BA. 2003. "Accumulation of silicon by bermudagrass to enhance disease suppression of leaf spot and melting out." USGA Turfgrass Env. Res. Online 2:1-6.

Deren CW, Datnoff LE, Snyder GH, Martin FG. 1994. "Silicon concentration, disease response, and yield components of rice genotypes grown on flooded organic histosols." *Crop Sci.* 34:733-737.

Kim SG, Kim KW, Park EW, Choi D. 2002. "Silicon-induced cell wall fortification of rice leaves: a possible cellular mechanism of enhanced host resistance to blast." *Phytopathology* 92:1095-1103.

Raid RN, Anderson DL, Ulloa MF. 1992. "Influence of cultivar and amendment of soil with calcium silicate slag on foliar disease development and yield of sugar-cane." *Crop Prot.* 11:84-87.

Seebold KW, Datnoff LE, Correa-Victoria JF, Kucharek TA, Snyder GH. 2000. "Effect of silicon rate and host resistance on blast, scald, and yield of upland rice." *Plant Dis.* 84:871-876.

Seebold KW, Kucharek TA, Datnoff LE, Correa-Victoria JF, Marchetti MA. 2001. "The influence of silicon on components of resistance to blast in susceptible, partially resistant, and resistant cultivars of rice." *Phytopathology* 91:63-69.

Street JR, Henderlong PR, Himes FL. 1981. "The effect of silica rates on the growth, silica deposition and water absorption among three turfgrass species." Int. Turfgrass. Res. Conf. 4:259-266.

Uriarte RF, Shew HD, Bowman DC. 2004. "Effect of soluble silica on brown patch and dollar spot of creeping bentgrass." *J Plant Nutr.* 27: 325-339.

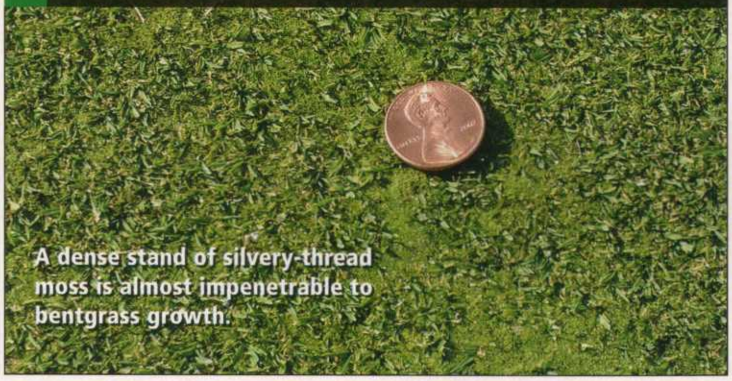
Waddington DV 1989. "A complete fertility program for healthy turf." Proc. 59th Annual Michigan Turfgrass Conf. 18:153-155.

New Control Option Available for Moss on Bentgrass Greens

By Scott McElroy and Greg Breeden

"Moss is a weed problem in turf." When non-golf course people hear me make this comment during a presentation, they think I'm joking. Some get a quizzical look on their face, like they are trying to solve a hard math problem.

FIGURE 1



A dense stand of silvery-thread moss is almost impenetrable to bentgrass growth.

But for superintendents, moss is a real problem. Specifically silvery-thread moss (*Bryum argenteum*) is an increasing problem on bentgrass putting greens. The dense stands that moss develops on a bentgrass green (Fig. 1) are virtually impenetrable to bentgrass growth.

Moss does not seem to conform to environmental conditions either, so it is difficult to pinpoint specific causal agents. It appears in shade and sun. Dry and wet conditions. Native soil and constructed, sand-based greens. North or south, east to west. It seems to appear everywhere or nowhere.

While moss contamination cannot be attributed to certain environmental weather factors, it can be correlated with management practices. In other words, moss is a problem that you create a niche for it to thrive. All for the sake of green speed.

To determine what gives moss a chance to survive, think of some of the practices you undertake to speed up your greens, namely lower nitrogen fertility and more intense mowing practices. Both of these practices decrease the competitive ability of the bentgrass, specifically the ability of the bentgrass to recover from injury. And soon that slow-to-recover divot is filled with moss.

To control moss and regain a healthy stand of turf, superintendents have tried numerous different ideas — all with varying degrees of success but no consistency. Researchers have tried numerous ideas, such as utilizing copper, iron and fungicides, but these products have had varying degrees of success and injury to the bentgrass has been observed (Burnell et al. 2003).

Traditional herbicides currently on the market haven't been of much help either. If they controlled the moss, it injured the bentgrass, or if no injury to the bentgrass, no moss control. For example, many traditional herbicides such as 2,4-D and dicamba [neither of these herbicides controls moss] that are only active on broadleaf weeds and not grasses still have restrictions on how they can be used on bentgrass golf course greens. This is because bentgrass under greens management conditions is under such stress that it has a difficult time metabolizing any herbicide.

QuickSilver is a new herbicide product from FMC that contains a single active ingredient, carfentrazone. Carfentrazone is a contact herbicide that is active only on broadleaf dicot weeds, such as henbit, white clover and chickweed.

Because carfentrazone is a contact material in nature and does not translocate through the plant, one should not expect complete control of large plants. For this reason, carfentrazone has recently been included in products such as PowerZone and SpeedZone that contain broadleaf herbicides such as 2,4-D, dicamba, MCPP and MCPA. In these products carfentrazone aids in providing faster weed control, but the end result is usually the same.

QuickSilver, however, has filled the niche for moss control with bentgrass safety. In one of those odd phenomena, it was discovered that QuickSilver provides excellent control of moss, with no injury to bentgrass greens (Fig. 2). Because this herbicide solves a problem for turfgrass managers, a special registration label is in

Continued on page 66

Floratine

QUICK TIP

Floratine recommends fertility strategies to provide all the essentials required for strong turf. In practice, this means maximizing soil availability of nutrients and supplementing with foliar feeding as needed to insure linear supplies of all the essentials, all the time, in appropriate amounts.

Continued from page 64
the process of being submitted to EPA for use of QuickSilver on bentgrass greens in Tennessee for moss control.

Extensive research around the country has confirmed that bentgrass is extremely tolerant of QuickSilver, even up to 6X the label rate of 2.2 fluid ounces per acre (McElroy and Breeden 2005). Extensive testing was conducted at the University of Tennessee this year to evaluate tolerance of several bentgrass cultivars to QuickSilver. No injury was observed on four of the five greens that were evaluated (Table 1).

But the one golf green that was injured was a problem, because if one green could be injured, how many more would be injured when this product enters wide spread use? This one case of injury had the potential to jeopardize the entire registration process for using QuickSilver on bentgrass golf greens for moss control. But some differences began to come to light regarding QuickSilver injury at this golf course. Working with superintendent Steve Livesay at the Crossings in Fall Branch, Tenn., we came up with two possible reasons why injury was observed and why this situation was unique.

First, core aerification and sand top dressing occurred approximately three days prior to the initial QuickSilver application. Everyone knows that these abrasive management practices are absolutely necessary for the sustainable management of bentgrass putting greens. It is not known, however, if the stress induced by cultural practices, such as core aerification, topdressing and also verticutting create a situation where the bentgrass is more susceptible to turfgrass injury.

It seems intuitive that this would be the case but there are no studies that indicate that this is true. But from our experience at The Crossings, the cultural management prior to treatment most likely created a turf primed for injury.

Second, when we started closely evaluating the injury observed on the bentgrass green at The Crossings, one revelation quickly came to light: Underlying all of the damaged turfgrass was the weed we were targeting — moss. In other words, in the areas where injury occurred, moss was present below the grass canopy, hiding, probably already causing a lot of stress to the bentgrass before we treated with QuickSilver.

When we began looking closer it was apparent there was a lot more moss in this putting green than just the circular spots as observed in Figure 1. Most of the moss seemed to be invisible until you part back the bentgrass leaves and look below the canopy.

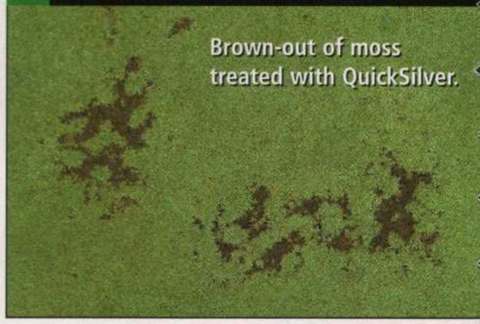
These observations will most likely lead to precautionary statements being added to the QuickSilver label. Here are some of those probable precautions that one will have to take when using QuickSilver for moss control in bentgrass greens:

- Wait two weeks after aerification or verticutting practices before applying QuickSilver.
- If injury is observed, wait until the bentgrass is completely recovered (three to four weeks) before making a second application.
- Do not apply to bentgrass that is under stress.
- Do not apply above 85 degrees Fahrenheit.
- Make sure you have a clean spray tank. Any contaminants can quickly lead to damaged bentgrass.

Develop management plan

As discussed earlier, moss is a problem that we create an environment for it to thrive. So simply killing it with QuickSilver will not solve the problem. You must increase the vigor of the turf to fill in damaged areas and prevent moss invasion. To this end, here is a more adaptive strategy for controlling moss:

FIGURE 2


Brown-out of moss treated with QuickSilver.

- Apply QuickSilver at 6.7 fluid ounces per acre. Evaluate injury to bentgrass. If injured, discontinue use for four weeks to allow recovery.
- Apply a second application at 6.7 fluid ounces per acre, two to three weeks later according to label recommendations.
- Increase fertility to a practical level based on your current fertility use throughout the application period to improve recover of the bentgrass.
- Possibly integrate light verticutting or grooming after QuickSilver applications to disturb the killed thick moss mat and stimulate bentgrass growth.

Final thoughts

QuickSilver has been a unique find in the turfgrass weed science arena. While precautions have arisen, this is normal in the development of a herbicide program.

No herbicide out there is completely safe and all herbicides must be used according to label recommendations to insure safe and effective use. In all cases, remember to consult the herbicide label for specific directions and precautions before applying any herbicide.

Special thanks to Steve Livesay, superintendent at The Crossing Golf Course; Joe Kennedy and Jerry Craven, superintendents at the Little Course and The Vanderbilt Legends Club; and Bobby Campbell, superintendent of the University of Tennessee athletic fields, for use of their facilities in conducting this research.

Scott McElroy is an assistant professor of turfgrass and weed science at the University of Tennessee. Greg Breeden is a research and extension associate in the turfgrass and weed science department at the University of Tennessee.

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.

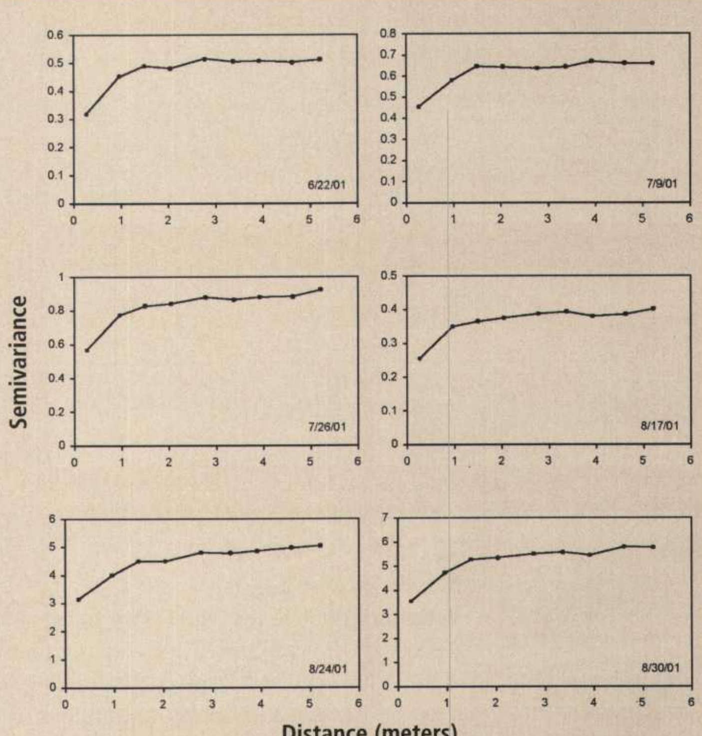
Some of the questions I addressed in my research included: Does dollar spot occur in a pattern? How does that pattern (if it occurs) change over a season? What are the management issues raised by the results? The answers to these questions will lead to a better understanding of this important turfgrass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



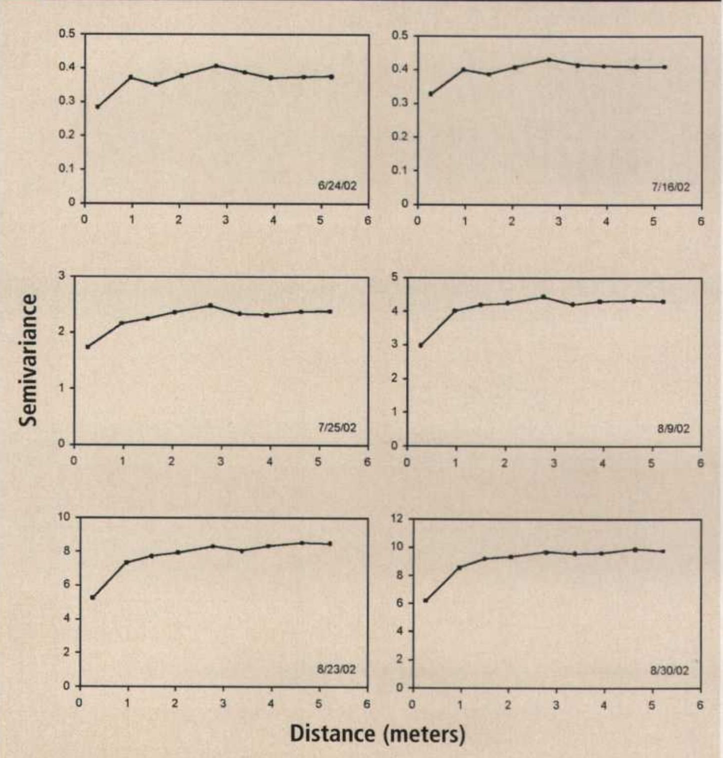
Variograms of dollar spot epidemic caused by *S. homoeocarpa* on a mixed sward of creeping bentgrass and annual bluegrass on six dates in 2001 selected to be representative of changes in disease progress throughout the growing season.

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

Continued on page 68

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.

Continued from page 67

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

Continued on page 70


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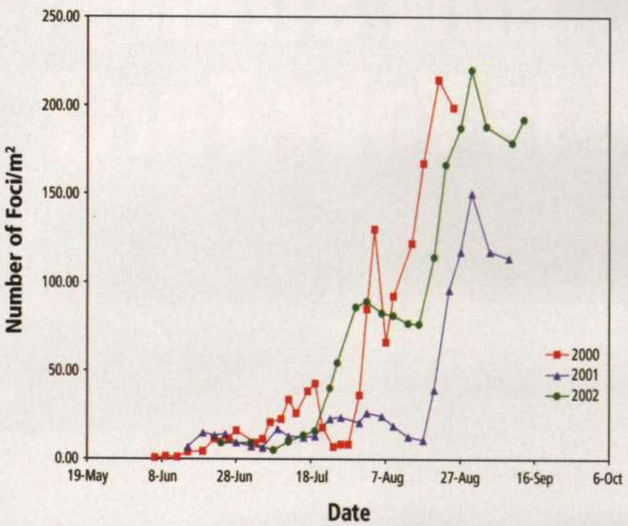
FIGURE 2



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}.

Continued from page 68

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.

REFERENCES

Fenstermacher JM. 1980. "Certain features of dollar spot disease and its causal organism *Sclerotinia homoeocarpa.*" Pages 49-53 in: Advances in Turfgrass Pathology. Eds. P. O. Larsen and B. G. Joyner, Harcourt, Brace, Jovanovich, Duluth, Minn.

Goovaerts P. 1997. "Geostatistics for Natural Resources Evaluation." Oxford University Press, New York.

Goovaerts P. 1998. "Geostatistical tools for characterizing the spatial variability of microbiological and physico-chemical soil properties." *Biol Fertil Soils* 27:315-334.

Isaaks EH, Srivastava RM. 1989. "An Introduction to Applied Geostatistics." Oxford University Press, New York.

Vargas JM Jr. 1994. Management of Turfgrass Diseases. 2nd ed. Lewis Publishers, Ann Arbor, Mich.

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.

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