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# TURFAX™

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## IN THIS ISSUE



## Dollar Spot: Getting Tougher to Manage in Creeping Bentgrass

*Peter H. Dernoeden*

Dollar spot (*Sclerotinia homoeocarpa*) is widespread and extremely destructive to turfgrasses. The taxonomy of *S. homoeocarpa* is unclear, and this fungus may be referred to as an unknown species of either *Moellerodiscus* or *Lanzia*. **Dollar spot is known to attack most turfgrass species**, including annual bluegrass (*Poa annua*), bentgrasses (*Agrostis* spp.), fescues (*Festuca* spp.), Kentucky bluegrass (*Poa pratensis*), perennial ryegrass (*Lolium perenne*), bermudagrass (*Cynodon* spp.), zoysiagrass (*Zoysia* spp.), centipedegrass (*Eremochloa ophiuroides*), and St. Augustinegrass (*Stenotaphrum secundatum*).

**Symptoms**. The symptomatic pattern of dollar spot varies with turfgrass species and cultural practices. Under close mowing conditions, as with intensively maintained bentgrass, annual bluegrass, bermudagrass or zoysiagrass, **the disease appears as small, circular, straw-colored spots of blighted turfgrass about the size of a silver dollar (4 cm diameter)**. With coarser-textured grasses that are suited to higher mowing practices, such as Kentucky bluegrass or perennial ryegrass, the blighted areas are considerably larger, and **straw-colored patches range from 3 to 6 in. (7.6–15.2 cm) in diameter**. Affected patches frequently coalesce and involve large areas of turf.

**Grass blades often die from the tip, and have straw-colored or bleached-white lesions that are shaped like an hour glass**. The hour-glass banding on leaves is often made more obvious by a definite narrow brown, purple, or black band, which borders the bleached sections of the lesion from the remaining green portions. Hour-glass bands may not appear on warm-season grasses, and are difficult to find on close-cut bentgrass or annual bluegrass on putting greens. On close-cut putting greens and warm-season grasses, the lesions are oblong or oval-shaped, but there is a brown band of tissue where the tan or white lesion and green tissue meet. Tip die-back of leaves is common and blighted tips appear tan to white in color, and also have a brown band bordering dead and green leaf tissue. A fine, white, cobwebby mycelium covers the diseased patches during early morning hours when the fungus is active and leaf surfaces are wet.

**Environmental Influences**. The disease is **favored by warm and humid weather, and when night temperatures are cool long enough to permit early and heavy dew formation**. In cool-season grasses, disease severity usually peaks in late spring to early summer and again in late summer to early autumn. In the upper Midwest, however, the disease tends to be most damaging during autumn. In some regions, dollar spot can remain active during mild periods throughout autumn and into early winter.

Dollar spot was widely regarded as a disease favored by warm days and cool nights. Therefore, in most regions in the United States it was generally believed to be primarily a problem from late spring to early summer and autumn in cool-season grasses. In 1999 in the Mid-Atlantic region, however, dollar spot was extremely active in July and August, and there were serious outbreaks as late as

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## Dollar Spot...
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November and early December. July and August weather conditions were hot and rain-free in most of the eastern United States in 1999, creating the need for daily irrigation (usually nighttime). Dollar spot was especially a chronic problem in annual bluegrass and creeping bentgrass turf on golf courses. **Why this dramatic change in the incidence and severity of dollar spot during hot and dry weather?** Although not clearly understood, some reasons may include: (1) more frequent night irrigation, which extended leaf wetness duration periods; (2) lower inputs of nitrogen; (3) lower mowing heights, more frequent mowing, and the removal of clippings; (4) intense play and wear, especially where mowers turn in fairways or approaches and in cupping areas; and (5) a lack of good thatch and soil compaction control programs on fairways and tees.

**Species-Cultivar Susceptibility. For some golf courses, the greatest contributing factor was the seeding of creeping bentgrass cultivars highly susceptible to dollar spot**, such as "Crenshaw," "SR 1020," and "Backspin." Undoubtedly, another factor was the overload of inoculum (i.e., the parts of the pathogen that cause disease). As disease severity increased over the season the amount of inoculum (i.e., mycelium of the dollar spot fungus, which does not produce spores) increased to very high levels. This resulted not only in an increase in the incidence and severity of the disease (even in cultivars with improved dollar spot resistance), but also longer periods of time when the disease remained active.

**A similar phenomenon occurred with red thread when perennial ryegrass was introduced on a large scale onto golf courses in the early 1980s**. At that time, red thread (*Laetisaria fuciformis*) disease was primarily a problem on fine-leaf fescues in maritime climates of New England and the Pacific Northwest. Red thread, however, also is a common disease of perennial ryegrass, which, as previously noted, was not generally grown on golf courses before 1980. As the years progressed, red thread first appeared in and severely damaged ryegrass in roughs. As inoculum (a combination of *L. fuciformis* mycelium, sclerotia, and spores) builtup, the disease spread to ryegrass on tees, fairways, and collars. By the 1990s, red thread was attacking Kentucky bluegrass and tall fescue, two species once believed to be very resistant if not immune to red thread.

Hence, a similar phenomenon may now be occurring with dollar spot in creeping bentgrass. This is especially true in the Mid-Atlantic region, where bentgrass is rapidly replacing perennial ryegrass as the preferred grass for tees and fairways. **The inoculum load is now so great on some courses that dollar spot is causing severe problems in Penncross, Procup, Southshore, and other cultivars reported to have moderate to high dollar spot resistance.**

**Cultural Management. Dollar spot tends to be most damaging to poorly nourished turfs, particularly if humidity is high or a heavy dew is present.** On putting greens, the removal of dew and leaf-surface exudates by poling, dragging, or whipping can be beneficial. Mowing greens early in the morning will speed surface drying, and has been linked to reduced dollar spot. In poorly nourished turf, an application of nitrogen (50% water-soluble plus 50% slow release) will stimulate shoot growth and mask the disease. Subsequent applications at low rates of water-soluble nitrogen (i.e., 0.1 to 0.125 lb N/1000 ft$^2$; 5–6 kg N/ha) in spoon-feeding programs throughout the golf season also helps to suppress dollar spot. Potassium, and to a lesser extent phosphorus, can help to reduce dollar spot, so it is important to maintain a balanced N-P-K fertility program.

**Raising mowing height is among the most effective cultural approaches to minimizing dollar spot injury**. Rolling (no more than 3 times weekly) has been shown to reduce dollar spot, whereas wear from turning mowers can increase dollar spot. Thatch layers and soil compaction long have been recognized to promote disease. **Hence, core cultivation to alleviate soil compaction and to control thatch should assist in reducing dollar spot**.

**Avoid light and frequent irrigation, especially when programming overhead irrigation systems for nightly applications of water**. When soils become too dry, irrigate deeply to the root zone depth during early morning hours. Irrigating between 5 A.M. and 8 A.M., when dew is present on leaves, does not extend the fungal infection period. Hence, where water use is restricted to the hours between sundown and sunup, predawn irrigation will not promote disease and will not violate local watering laws.

**Avoid using highly susceptible turfgrass cultivars**, such as Crenshaw or SR 1020, for fairways, where the most acres of turf are maintained on golf courses. According to the 1994–1997 bentgrass NTEP trials, L93, Pennlinks, Providence, and Penncross ranked high in dollar spot resistance.

**Chemical Management**. The fungicides commonly used for dollar spot control are shown in Table 1. Except for Daconil® (chlorothalonil), all are penetrants representing three different chemical classes each with different modes-of-action: (a) sterol inhibitor/dimethylene inhibitor (SI/DMI), (b) thiophanate, and (c) dicarboximide. Tank mixing a fungicide with 0.1 and 0.125 lb nitrogen per 1000 ft$^2$ (5–6 kg N/ha) from urea is associated with improved dollar spot control. The nitrogen stimulates growth, en-

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FEATURE ARTICLE

# Springtime Preventive Control of Black Turfgrass Ataenius

*Daniel A. Potter*

Golf superintendents who normally don't expect grub problems until late summer may be caught off guard and discover high numbers of small grubs, sometimes 200 or more per square foot, damaging turf in late May or June. Black turfgrass ataenius (BTA) (*Ataenius spretulus*) should be suspected in this situation. **This grub species causes sporadic, severe damage to golf courses throughout the cool-season turfgrass zones** from New England and the mid-Atlantic states west to Colorado, and also in California. Unlike other grubs, which are largely restricted to fairways, tees, and roughs, **the BTA also infests putting greens. Preventive action in April and May can help you to avoid BTA damage later in the summer**.

BTA differs from other turf-infesting white grubs in that **there are two generations per year throughout most of its range. The turf damage appears about mid-June and mid-August in the latitude of southern Ohio, West Virginia, and Nebraska, coinciding with the first and second annual broods of grubs**. There is only one generation in the Great Lakes states, northern New England, Ontario, and other northern parts of the species' range. The University of Nebraska entomology website (http://ianrwww.unl.edu/ianr/entomol/turfent/documents/ataenius.htm) has excellent photos of BTA and an illustration of its life cycle. The book *Destructive Turfgrass Insects* (Ann Arbor Press) lists detailed management strategies.

Adult BTA are shiny black beetles, 3/16- to 1/4-in. (4.8–6.4 mm) long, with distinct longitudinal grooves on the wing covers. On warm, sunny afternoons in late March or April, the beetles begin flying from overwintering sites, usually wooded lots, to their preferred egg-laying haunts, mainly moist, thatchy golf course fairways, tees, and greens. In southern Ohio, **the beetles begin emerging about when crocus and eastern redbud are blooming. Adults may be seen crawling on putting greens or fairways, and the beetles may be noticed in mowing baskets, among the clippings**. Egg-laying continues through May, often into early June. Eggs hatch in about a week, and the grubs feed on fine roots and organic matter. Full-sized BTA grubs are small, about the size of Lincoln's hair on a U.S. penny. **Individual grubs take about a month to mature**, then burrow down, pupate, and emerge as adults in late June and July. These beetles produce a second brood of grubs that damages the turf in late summer and early autumn. New adults emerge in September and October, mate, and fly back to overwintering sites.

Preventive control can be effective where BTA is a recurring problem. **One option is a spray application to intercept the beetles as they return to the turf in the spring**. Certain flowering plants are useful for timing because their blooming coincides with the pest's egg-laying activity. **Spraying when Vanhoutte, Bridal Wreath, or Bridal Veil spireas are in full bloom**, covered with white flowers, can effectively eliminate the BTA adults before they lay eggs. Full bloom of horse chestnut, and first bloom of black locust also coincide with the treatment window. Or, you can watch for adults crawling on putting greens or showing up in mowing baskets.

Dursban® at 2.0 lb ai/acre has been the standard treatment, but recent field trials indicate that the pyrethroids—DeltaGard®, Scimitar®, and Talstar®—work equally well. Apply sufficient spray volume, or irrigate lightly to wash the insecticide off the grass blades, so that residues are deposited in the upper thatch.

**Another option is to preventively control the grubs with a long-residual soil insecticide**. Merit® (imidacloprid) applied in mid-May will eliminate BTA grubs as they begin feeding, as well as Japanese beetle, masked chafer, and other annual grub species that hatch later in July or early August. April applications may be too early—they'll control the first generation of BTA, but the residues may be gone before the larger, annual grub species have hatched. MACH 2® applied in late May or the first week of June will control BTA and subsequent annual grubs.

BTA can also be controlled curatively by targeting the grubs with a short-residual soil insecticide (e.g., Dylox® or Turcam®). Irrigate after treatment to move the insecticide through the thatch. As with all curative treatments, the younger the grubs, the easier they are to control.

# The Effects of Primo on Penncross Creeping Bentgrass Root Growth

*Fred Yelverton*

The effects of any cultural practice or application of any product to a bentgrass putting surface is of concern to golf course superintendents. Of particular concern are the effects of any practice on bentgrass root growth. Of course, it is much more difficult for turfgrass managers to assess the effects of various chemical and cultural practices on root growth. In an effort to view root growth, most turf managers use a cup cutter or profile indicator, and take a slice to view the roots. While this can be helpful, it is not a good indicator of root biomass (root weight) but rather, is an indication of rooting depth. Root biomass may or may not correlate to rooting depth. Total root biomass is a better indication of root growth than root depth.

Measuring root biomass under field conditions is also very difficult for turfgrass scientists. The procedure generally accepted by turfgrass scientists is to take multiple cores, wash away as much soil as possible, dry the resulting root sample, obtain a weight, ash the sample at a very high temperature (usually around 900°F)—which removes all the root biomass—and then re-weighing the resulting material. Root weights are then determined from the difference in weight from pre-ashing and post-ashing. Such measurements are very labor intensive and are expensive. In addition, very small differences in root weights can be difficult to detect. Also, quantifying root weights in sand culture is more accurate than in finer-textured soils because it is easier to remove roots from sand-based soils than silt or clay soils.

The effects of trinexapac-ethyl (Primo®) and other plant growth regulators on bentgrass root growth is a much-debated topic among turfgrass managers and turfgrass scientists. And of course, any positive or negative effects on root growth affect the stress tolerance of bentgrass and other turf species. In fact, the manufacturer of Primo®, Novartis, contends their product will "condition" the plant to stress if applied prior to the stressful conditions. "Pre-stress conditioning" is the term most often used by the manufacturer. What is the basis on which they make these claims?

Before this can be addressed, it is important to understand the mode-of-action of Primo®. It is well documented that **Primo® is a foliar absorbed product that suppresses gibberellin biosynthesis in plants**. Gibberellins have several effects in green plants, such as cell and stem elongation. **Therefore, by suppressing gibberellin biosythesis in plants, Primo® and other plant growth regulators that have similar modes-of-action (paclobutrazol or TGR Turf Enhancer® and flurprimidol or Cutless®) result in a shorter, more compact plant**. This is the reason why the mowing requirement can be reduced with turf plant growth regulators that suppress gibberellin biosynthesis. Research has shown these products to be effective in reducing the mowing requirement of various turf species.

Previous studies have also shown that **a vast majority of Primo® remains in above-ground plant parts**. Therefore, the argument goes that Primo® only slows above-ground shoot growth and therefore photosynthates are redirected down into root systems, thereby increasing root growth. Does this really happen?

A hydroponics study was initiated at North Carolina State University to evaluate the effects of Primo® on root growth of "Penncross" creeping bentgrass. Because it is a soilless medium, root biomass can be easily quantified with a high level of accuracy and precision. Seven root-zone temperatures were utilized to determine if Primo® had a different effect when the root-zone temperature was altered. Root-zone temperatures were 57, 64, 72, 79, 86, 93, and 100°F (14, 18, 22, 26, 30, 34, and 38°C). Bentgrass plants were treated with Primo®, then exposed to the various root-zone temperatures, and allowed to grow for 2 weeks prior to harvest. The results of the effects of Primo® on bentgrass root growth are shown in Figure 1.

**Primo® had a significant positive effect on bentgrass root growth at 5 of the 7 temperatures**. Only at the 2 **extreme temperatures—57 and 100°F—did Primo® fail to increase root growth**. However, while root growth was enhanced, the resulting increase was very small. The increase in root growth was no more than 10% at any temperature. Therefore, the increase was so small one could argue that it has no biological significance and may not mean anything under field conditions. However, **the results of this study clearly indicate that root growth was increased, albeit very small**. Therefore, the debate continues.

Also note that **when temperatures exceeded 79°F, bentgrass root growth slowed**. At 93 and 100°F (34 and 38°C), bentgrass roots were severely injured and root death was obvious.

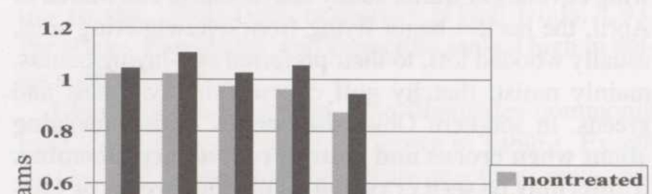


Figure 1. 'Penncross' bentgrass fresh root weights at various root-zone temperatures with and without Primo.

FEATURE ARTICLE

# Low-Temperature Kill

James B Beard

A major cause of winter injury of both cool- and warm-season turfgrasses is low-temperature kill. **It is caused by ice crystal formation and resultant stress at temperatures below 32°F (0°C)**. This stress may be either an intracellular or extracellular occurrence, in which the brittle protoplasmic organization is fatally damaged via mechanical destruction. **Typically, the higher the hydration level or water content in the cells of sensitive tissues such as the meristems, the greater the likelihood of low-temperature kill. Note that low-temperature kill is distinctly different from chilling stress injury**.

A question frequently asked is—"at what temperature will a particular turfgrass species or cultivar be killed?" A knowledgeable individual will not attempt to answer this question, as it varies greatly depending on the environmental conditions during freezing and the degree of plant low-temperature hardiness as influenced by environmental and cultural factors. In terms of freezing conditions, **the absolute temperature at which a particular turfgrass is killed may vary depending on the (a) freezing rate, (b) thawing rate, (c) number of times frozen, (d) length of time frozen, and/or (e) post-thawing culture**.

**Low-Temperature Kill Hardiness. The hardiness of turfgrasses to low-temperature kill involves the ability of a plant to survive potentially lethal low-temperature stress at temperatures below 32°F (0°C)**. It is achieved primarily by the redistribution of water, including lowering the hydration level of the critical meristematic tissues, and usually an increase in carbohydrate storage. For most turfgrass species, **temperatures between 34 and 40°F (1–4°C) are optimum for the low-temperature hardening process to occur**. The relative low-temperature kill hardiness of 31 autumn-hardened turfgrasses is shown in the accompanying table.

Influential environmental factors that contribute to low-temperature hardiness typically affect the plant tissue hydration level. They include **poorly drained soils**, with fine, clayey soil textures or compacted soil conditions, increasing the likelihood of surface water accumulations that result in increased tissue hydration. Depressional areas where water stands following intense rainfall and/or mid-winter thawing of snow also accentuate tissue hydration. **High sunlight or irradiance** enhances physiological hardening via an increased carbohydrate accumulation. **Accelerated shoot growth usually adversely increases the tissue hydration level.** Influential cultural factors that may contribute to enhanced low-temperature hardiness, especially during the hardening period, include:

- high tissue potassium levels.
- moderate to low tissue nitrogen levels.
- higher mowing heights that increase carbohydrate storage.
- avoidance of excessive irrigation.
- ensuring proper surface and subsurface water drainage.
- control of excessive thatch, which elevates the nodes on lateral stems.
- selection of low-temperature hardy turfgrass species and cultivars.

| Relative Low-Temperature Kill Hardiness | Turfgrass | Scientific Name |
|---|---|---|
| excellent | rough bluegrass | *Poa trivialis* |
| | creeping bentgrass | *Agrostis stolonifera* |
| | turf timothy | *Phleum bertolonii* |
| good | Kentucky bluegrass | *Poa pratensis* |
| | Canada bluegrass | *Poa compressa* |
| | velvet bentgrass | *Agrostis canina* |
| | crested wheatgrass | *Agropyron cristatum* |
| | colonial bentgrass | *Agrostis capillaris* |
| | redtop | *Agrostis gigantea* |
| moderate | creeping bluegrass | *Poa annua* var. *reptans* |
| | fine-leaf fescues | *Festuca* spp. |
| | American buffalograss | *Buchloe dactyloides* |
| | blue grama | *Bouteloua gracilis* |
| | annual bluegrass | *Poa annua* var. *annua* |
| | perennial ryegrass | *Lolium perenne* |
| | tall fescue | *Festuca arundinacea* |
| | meadow fescue | *Festuca pratense* |
| | Japanese zoysiagrass | *Zoysia japonica* |
| poor | dactylon bermudagrass | *Cynodon dactylon* |
| | manila zoysiagrass | *Zoysia matrella* |
| | seashore paspalum | *Paspalum vaginatum* |
| | hybrid bermudagrass | *Cynodon* hybrid |
| very poor | centipedegrass | *Eremochloa ophiuroides* |
| | mascarene zoysiagrass | *Zoysia tenuifolia* |
| | common carpetgrass | *Axonopus fissifolius* |
| | annual ryegrass | *Lolium multiflorum* |
| | bahiagrass | *Paspalum notatum* |
| | St. Augustinegrass | *Stenotaphrum secundatum* |
| | kikuyugrass | *Pennisetum clandestinum* |
| | tropical carpetgrass | *Axonopus compressus* |
| | serangoongrass | *Digitaria didactyla* |

## Dollar Spot...

*Continued from page 2*

abling plants to produce shoot tissue faster than the fungus can cause disease, and helps to speed recovery of injured plants.

**When targeting dollar spot, it is important to rotate fungicides from each of the three classes**. That is, there is no advantage to rotating Banner MAXX®, Bayleton®, Eagle®, or other SI/DMI fungicides. Rotating fungicides with different modes-of-action helps to delay the possible selection of resistant biotypes of the dollar spot pathogen. Because there has never been a report of an *S. homoeocarpa*-resistant biotype of Daconil®, it is especially important to use Daconil as a tank-mix partner with one of the penetrants or to just rotate it into the spray program often.

Loss of good residual dollar spot control with any particular fungicide does not necessarily mean resistance is developing. The overuse of materials within the same chemical class can result in enhanced microbial degradation. That is, **continuous use of fungicides from within any of the three classes listed could give rise to a build-up of bacteria that use fungicides in that class as an energy source. This results in a more rapid degradation of fungicides, thus reducing their residual effectiveness**. Another common reason for poor residual control is using low water dilutions for spraying. Ideally, fungicides should be applied in at least 90 gallons of water per acre and sprayed through nozzles that will atomize the droplets. There is a trend to water-in fungicides. It is important to note, however, that **there are few if any studies that have shown a benefit from watering-in fungicides for dollar spot control**. For all we know, you may be losing efficacy by watering-in certain products. Daconil®, because it is a contact fungicide that provides disease control on leaf and sheath surfaces only, should never be watered-in.

Fungicides like ProStar® (flutalonil) and Heritage® (azoxystrobin) have no activity on dollar spot, and some studies have shown that they can occasionally encourage dollar spot. Research has shown, however, that tank-mixing ProStar® or Heritage® with either Banner MAXX® (propicnazole), Bayleton® (triadimefon) and other sterol-inhibitors helps to ensure that dollar spot is not encouraged, nor will dollar spot rebound once the effects of the Banner MAXX® or Bayleton® dissipate. There is, however, no established link between dollar spot outbreaks and the now common use of the plant growth regulators Primo® (trinexapac-ethyl), Scotts TGR/Turf Enhancer® (paclobutrazol), or Cutless® (flurprimidol). In fact, **Primo® has been shown to enhance the residual effectiveness of some fungicides, and TGR and Cutless actually have fungicidal activity that reduces the severity of dollar spot.**

Ultimately, effective dollar spot suppression is going to involve combining those cultural practices that are known to suppress dollar spot into any fungicide program. In particular, nitrogen should be added to the spray tank (i.e., 0.1–0.125 lb N/1000 ft$^2$ from a water-soluble N-source like urea) each time a fungicide is applied for dollar spot control. It is important to mow early in the morning to speed drying of the turf. **Fungicide-treated turf, however, should not be mowed for at least 24 hours after spraying**. Obviously, removal of plant tissues containing fungicides dilutes the total concentration of the product. This is why **using plant growth regulators to reduce mowing frequency can sometimes help to extend residual effectiveness of certain fungicides**. Returning clippings is helpful if they do not interfere with play, because they help to recycle nitrogen and other nutrients. **Avoid frequent night irrigation**. There is an overuse of the overhead irrigation system by some superintendents, and bentgrass fairways in particular should be kept on the dry side through the summer. Core cultivation, topdressing, vertical cutting, and other cultural practices that help reduce thatch and alleviate soil compaction are important to the overall health and playability of golf turf. These cultural practices, however, are best performed during disease-free periods when the bentgrass is actively growing. **Try to minimize wear damage by skipping perimeter mowing one or two days a week**. Avoid other types of mechanical injury (i.e., topdressing, brushing, etc.) during periods when dollar spot is active and bentgrass is not growing vigorously.

**Table 1. Fungicides for dollar spot control.**

| SI/DMI | Thiophanates |
|---|---|
| Banner MAXX | CL 3336 |
| Bayleton | Fungo |
| Eagle | **Dicarboximides** |
| Lynx* | Chipco 26GT |
| Rubigan | Curalan/Vorlan/Touche |
| Sentinel** | **Other** |
| Triton* | Daconil |

* Currently not available; registration expected in 2000 or 2001.

** After existing supplies are sold, Sentinel will no longer be available for use on turfgrasses.

## EUROPEAN TRENDS

Fifteen lectures were presented by J. Beard in thirteen countries across Europe in January. Attendance and participation via interactive questions were excellent. In Austria, the very first turfgrass educational program was held. There are now 101 golf courses in Austria with 85 individuals in attendance at the seminar. The following comments are based on observations made during the lecture tour.

**Gnawed Turf.** A unique turfgrass injury problem was seen on a golf course near Toulouse, France. A putting green located adjacent to a pond was damaged by large, irregular shaped areas scattered across approximately 20% of the turf. **Close, consecutive rows of elongated, closely defoliated turfgrass shoots were revealed**. Further examination revealed **a gnawed-like appearance**, much like that of rats gnawing on wood. The damage was attributed to what they call a water rat in France, which had been introduced from the United States. It most probably is what is known in the United States as the muskrat (*Ondatra zibethica*), an aquatic rodent.

**It Won't Happen Here!** Water restrictions on turfgrass areas continue to increase worldwide. There are now water restrictions in place for golf courses and certain other turf areas in such countries as Denmark, Luxembourg, and parts of the United Kingdom. As I have stated in many lectures over the years, **water will be the key limiting factor in the culture of turfgrasses during the 21st century**.

**Moss Problems.** Questions concerning moss and algae problems are common in most countries. This is a reflection of the trend to closer mowing heights in order to meet the demand of golfers for faster putting speeds on greens. As a result, many of the older turfgrass cultivars become thinned, resulting in sunlight reaching the soil surface. This provides conditions favoring the invasion of moss and algae.

A striking example of this was on a golf course in The Netherlands. There was no history of moss problems on the golf course. **For the entire 1999 growing season, it was decided to not fertilize the back championship tees**. By the end of the season and at the time of the visit **there was approximately 30% moss invasion only on the back championship tees**. It can be concluded that the lack of fertilization resulted in thinning of the turf to the extent that light reached the soil surface, thereby facilitating moss growth.

**Disease Trends.** The appearance of what are termed "new" diseases is occurring in certain countries in Europe. This is most probably a result of newer developments in the recognition and knowledge of the causal pathogens. In other words, these diseases have probably always been present to varying degrees, but were not properly diagnosed. For example, southern blight (*Sclerotium rolfsii*) has become a problem on putting greens in southern France. In the United Kingdom there is increased concern for such diseases as yellow patch (binucleate *Rhizoctonia* AG-D(I) and summer patch (*Magnaporthe poae*). Pythium blight (*Pythium* spp.) has become a threat in northern Italy. One of the more notable recent developments in the United States has been an accelerated problem with gray leaf spot (*Pyricularia grisea*) on closely mowed perennial ryegrass (*Lolium perenne*) turfs in warm-humid climates.

## RESEARCH SUMMARY

### The Influence of Humic Substances on Rooting and Nutrient Uptake

The potential for humic substances, including humate and humic acids, to influence root growth and nutrient uptake of creeping bentgrass (*Agrostis stolonifera*) was assessed in a sand root zone and in solution culture, both under greenhouse conditions. Humic substances are defined as a category of naturally occurring, biogenetic, heterogeneous, organic substances that can generally be characterized as being yellow to black in color, of high molecular weight, and refractory. The results revealed that **humate incorporated to a depth of 4 inches (10 cm) stimulated a 45% increase in root mass in the upper 4 inches (10 cm) and a 30% increase in root mass at the 4 to 8 inch (10–20 cm) depth, plus an increase in maximum root length of 15%**. In contrast, **foliar applied liquid humic acid did not exhibit significant affects on rooting**. The uptake of such nutrients as nitrogen, potassium, calcium, magnesium, and iron was not affected by humic substance applications. **By R.G. Cooper, C. Liu, and D.S. Fisher. 1998. *Crop Science*. 38:1639–1644**.

**Comments. These findings now need to be confirmed by research under normal field turfgrass growing conditions involving a living, biologically active soil condition**. The question that needs to be determined is whether the response to humate incorporation into a 100% sand would give a similar response under field conditions that include organic matter in the root zone.

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## JB COMMENTS

### USGA Root Zone Specialization

Often I hear references to putting greens constructed to "modified USGA specs" or to the "80-20 USGA spec." This naive philosophy most commonly leads to future problems. Unfortunately, many of these difficulties will not appear until 3 to 6 years later, at which time those involved do not relate it to the original construction procedure utilized. Basically, **a minimum of four and preferably five years is required before any conclusions can be drawn concerning the success of a root zone construction system**. This duration of time is required for the soil root zone to consolidate and for a biological ecosystem of bacteria, fungi, actinomyces and nematodes to reach a relatively stable state of equilibrium, thereby forming what is termed a **living root zone**.

It needs to be emphasized that **the USGA specifications are a range and not specific numbers**. Thus, there is built-in flexibility in the sand particle size distribution, plus the percentages of various organic and soil amendment components that may be used, depending on the specific materials available at a given site. **The turf performance criteria for the USGA specifications are achieved only if the root zone is constructed within the specifications**. It is just like constructing a concrete building or an asphalt roadway. In both cases, it is important to stay within the specifications. Otherwise, the long-term performance of these structures usually is lost. The same typically is true in the use of the USGA specifications for root zones.

## ASK DR. BEARD

**Q** *How does crown hydration cause winterkill of turfgrasses?*

**A** **Crown hydration is not a cause of winter-kill of turfgrasses**. Unfortunately a number of writers and speakers use this incorrect terminology.

Actually, tissue hydration is a physiological change that occurs in turfgrasses under certain conditions. **It results in increased proneness to low-temperature kill at tissue temperatures below freezing**. The basic cause of plant death is ice crystal formation either within or between cells, resulting in mechanical destruction of the critical protoplasmic organization within the individual cells.

One of the more common environmental scenarios in which tissue hydration occurs is during a mid-winter thaw, which commonly occurs sometime in February in locations such as Michigan and Wisconsin. **Typically associated with this thaw period is extensive standing water, which results in tissue hydration. If followed by a rapid freeze to temperatures below 20°F (–7°C)**, then low-temperature kill associated with the higher tissue hydration level is likely to occur. This is especially true of turfgrass species such as annual bluegrass (*Poa annua*), perennial ryegrass (*Lolium perenne*), and tall fescue (*Festuca arundinacea*).

Tissue hydration predisposing the plant to kill may not occur just in the crowns, but applies to all meristematic tissues including the crowns, plus the meristematic nodes on stolons and rhizomes. Thus, for strongly creeping turfgrasses, such as bermudagrass (*Cynodon* spp.), a **more correct terminology would be meristem hydration.**

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