TURFGRASS TRENDS

INSECT CONTROL

Identifying Billbugs Means Better Control Opportunities

By David J. Shetlar

Billbugs are some of the most commonly misdiagnosed insect pests on golf courses. Their damage is usually mistaken for disease symptoms, drought or other insect attack.

Billbug damage often goes undetected, especially when turf is regularly irrigated. The legless, grub-like larvae can cause cut sod to be quarantined or rejected, especially when transported across state lines.

Turf grown on slopes (around golf bunkers, for example) often exhibits billbug damage, but turf managers expect that turf in these areas is "naturally under drought and sun stress." Billbug damage can look similar to chinch bug, white grub and sod webworm activity (Vittum, et al., 1999; Niemczyk & Shetlar, 2000).

Billbug species

Cool-season, transition and warm-season turf species are all susceptible to billbug attack. These species of billbugs can be divided into two main groups — those that can overwinter as larvae (usually the species attacking warm-season/transition turf) and those that overwinter primarily as adult beetles (usually the species attacking cool-season turf).

There are about 50 species of billbugs that are recognized as inhabiting the United States and Canada, but most of these use wild grasses and sedges, or grain crops as hosts. All the species are placed in the genus *Sphenophorus* (formerly known as *Calendera*), and almost any species may be found wandering across turf, especially if the turf is located near wetland or prairie habitat, or where nutsedge weeds are present.

Mature bluegrass billbug larvae pupate in the soil and new adults emerge in July.

By far, most published information on billbug seasonal biology is based on the bluegrass billbug, *S. parvulus*. This species is found across most of North America (Niemczyk & Shetlar, 2000; Kindler & Spomer, 1986), including the southern states. Though most damage caused by bluegrass billbug appears in cool-season turf, this billbug has been found in noticeable numbers in several of the Gulf states.

Damage from bluegrass billbug has also been reported in transition zone zoysiagrass where the hunting billbug, *S. venatus*, is more commonly present.

Bluegrass billbugs typically overwinter as adults in and around turf. In April and May, these adults become active — feeding, mating, and seeking out suitable turf for egg laying. While named after Kentucky bluegrass, this billbug regularly infests perennial ryegrass, fine and tall fescues (if they don't contain endophytic fungi). The larvae burrow

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The hunting billbug appear to have prolonged adult activity periods that result in both the adults and larvae being present during the season.

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down the seed stems in late May into early June and can completely destroy crowns and new tillers by late June. Mature larvae pupate in the soil and new adults emerge in July.

If the turf is actively growing and conditions are not too dry, a second generation may be attempted by these new adults. However, in most cases, the summer-emerging adults appear to maintain themselves by periodically feeding at the bases of grass stems. They then seek out sheltered sites in the turf thatch or underlying soil in late September into October to overwinter.

Other billbugs

The lesser billbug, *S. minimus*, is commonly found in the Northeastern states, but its native range appears to be most of North America. This pest is often found with the bluegrass billbug, and it has a similar life cycle.

It is my belief that the lesser billbug prefers finer stemmed grasses, especially the fine fescues and bentgrass. It may also be associated with roughstalk bluegrass and nimblewill.

The hunting, Phoenician, and Denver billbugs (*S. venatus*, *S. phoeniciensis*, and *S. cicatristriatus*, respectively) have annual life cycles that are quite different than the bluegrass billbug's. These three billbugs appear to have prolonged adult activity periods that result in both the adults and the larvae being present over much of the season (Morishita, et al., 1971). Larvae of these billbugs commonly remain active during the winter as they continue feeding on dormant or slow-growing stolons and crowns.

Because of the dormancy in bermudagrass and zoysiagrass, the extent of billbug damage will not be evident until the next spring.

At this time, hunting and Phoenician billbug damage is commonly mistaken for spring dead spot (an actual disease) or "delayed spring green-up syndrome." As the larvae mature, from February into early May, they pupate and the new adults actively lay eggs for most of the summer months. Since bermudagrass and zoysiagrass grow so rapidly during the summer months, billbug larval damage is largely undetectable during the summer and early fall unless one digs for them or cuts sod.

The Denver billbug is most common in bluegrass and perennial ryegrass, especially in the irrigated turf of New Mexico and Colorado.

Identifying billbug species

It's nearly impossible to identify billbug larvae to species. Insect taxonomists have not studied these well, and most entomologists simply guess about the species from associations with turf species and geographic location.

Billbug adults are relatively easy to identify by using the shapes, sizes and patterns of pits, furrows and ridges visible on the pronotum and wing covers. The bluegrass billbug has numerous fine punctures on the pronotum, but sometimes there is a medial ridge without punctures that runs down the center of the pronotum.

The wing covers have smooth furrows that border neat rows of small punctures. *S. minimus* is usually a bit smaller than *S. parvulus*, but the pronotal punctures are distinctly of different sizes and the wing covers appear crumpled with irregular ridges and punctures.

Hunting billbugs are usually larger billbugs, three-eighths to one-half-inch long, and characteristically have a raised ridge in the center of the pronotum that divides into a small fork just before reaching the head (Diagram 3). This medial ridge is bracketed on each side with raised ridges that resemble parentheses marks.

Hunting billbugs can vary considerably in color, from a deep red-brown color to completely black. Some believe that the brown forms are ones that have recently emerged, but I'm not convinced of this. Hunting billbugs recovered from New Jersey up to Connecticut are often the same size as the bluegrass billbug,

but the pronotal markings remain distinct.

In Arizona and Southern California, the Phoenician billbug seems to be more common than the hunting billbug, though both can be found in the same turf. This species looks much like the hunting billbug, except that the raised areas on the pronotum have been expanded and they join to form a wide M-shaped pattern (Diagram 4). I have seen classically marked hunting billbugs and Phoenician billbugs together, and I'm not sure that these are actually distinctly different species. Further research, perhaps using genetic fingerprinting, will be needed to confirm or refute this idea.

The Denver (or Rocky Mountain) billbug, can be locally abundant in cool-season turf from New Mexico into Montana. It is a large species that has a black patent-leather look. The pronotum has numerous small pits, filled with white hairs and the wing covers have rows of heart-shaped pits, also filled with white hairs (diagram 5). Like the hunting billbug, this pest commonly has larvae that feed during the winter months.

To make things more complicated, I often find other billbug species in North American turf, especially in the Southern states, and my fellow entomologists occasionally find additional species of billbugs in cool-season turfs. Of these, the most notable one is a large species that looks much like the bluegrass billbug. This one, *S. coesifrons*, has no common name, but I find it commonly associated with bermudagrass and St. Augustinegrass from Oklahoma to Florida.

Diagnosing billbug attacks

Diagnosis of bluegrass and minimus billbug attack is very simple — use the "tug test." Simply grasp several of the affected stems and tug upward. Billbug damaged turf will have stems that break off easily, just below the thatch level, and the broken stems will be packed with a fine frass (Picture 1).

Since cool-season turfs are most commonly attacked by these two billbugs, perform the tug test any time that you see random dead grass stems (light infestations) to signs of early summer dormancy, apparently caused by drought conditions (heavy infestations).

Sunny, sloped areas most commonly show visual damage from billbugs. Unfortunately, these are also the areas that turf managers usually "feel" that the turf damage is merely from drought or heat.

Hunting and Phoenician billbug damage is much more difficult to diagnose. Even in bermudagrass and St. Augustinegrass, a tug test or two can indicate billbug activity.

In bermudagrass and zoysiagrass, look for small to medium patches of turf that appear to be dead, or at least the stems and leaves are straw-colored — especially in early spring when the turf is beginning to green up. If you use the tug test, affected stems will also pull out of the soil easily, but they will rarely be filled with frass. Most typically, the stems will appear to have been severed by something (as evidenced by having brown or black tips) and upon looking with a hand lens the broken ends will be slightly hollowed out. By brushing your hand back and forth in these areas, look for signs of numerous small bits and pieces of stolons.

Pick some of these up and inspect the ends for signs of being chewed off or hollowed out. I usually have to dig around in the soil to determine if billbug larvae are present in order to be absolutely sure that billbugs are the cause of the damage symptoms.

Hunting and Phoenician billbug damage is most evident in mowed roughs, tee banks, bunker slopes and other highly sloped, sunny areas.

As with the bluegrass billbug, damage in these areas is usually mistaken for lack of irrigation, but it can also look like nematode activ-

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Species Identification

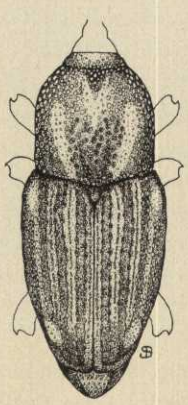

Diagram 3-Hunting Billbug

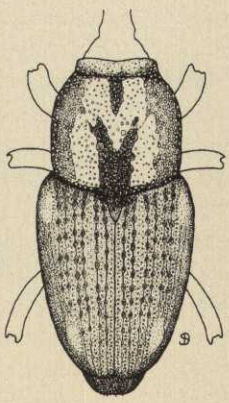

Diagram 4-Phoenician Billbug

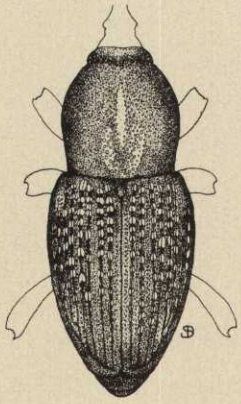

Diagram 5-Denver Billbug

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ity, mole cricket damage, armyworm feeding and disease attack. In any case, you'll likely need to get out a shovel, cut three sides of a large flap of the turf and peal it back to see if any billbug larvae are present. Hunting billbug larvae are often an inch deep or more in the profile.

Another easy way to determine if billbugs are candidates for causing turf damage is to simply be observant. All billbugs seem to like to "stroll" around. I commonly find billbug adults walking across greens and sidewalks, especially in the late afternoon. When I find a half dozen or more on a single green, I begin to look at the surrounding turf, especially the sloped areas.

Billbugs also commonly get trapped in golf course bunkers, especially ones with seep slopes. Walk around the edges of bunkers, and you'll usually find a few billbugs trying to climb out.

Managing billbugs

Control strategies for the bluegrass billbug are well-defined and understood, but hunting billbug management strategies are just now being defined.

For the bluegrass billbug, the full range of options is available: cultural controls (continuous irrigation and good fertilization), use of resistance (endophyte-containing ryegrass or fescues are toxic to billbugs), preventive and curative insecticides.

In cool-season turf, regularly irrigated and fertilized turf seems to outgrow billbug damage or the billbugs commonly become infected with the white fungus of insects, *Beauveria*. Field research has also shown that turf stands that contain 40 percent to 50 percent endophyte-infected stems are lethal to billbugs, and the billbugs rarely build up damaging populations.

To prevent billbug damage, turf managers often apply a surface or thatch targeted insecticide in late April into mid-May to kill the overwintered adults that are finding places to lay their eggs. Chlorpyrifos and most of the pyrethroids are useful in this mode. With the development of imidacloprid (Merit) and halofenozide (MACH 2), it has also been shown that these insecticides are good at preventing billbug damage if they are applied in May when the adults are laying eggs.

We're not sure whether these insecticides are actually killing the billbug adults or their residues are killing the larvae, but these early applications prevent damage. Note that Merit is to be used at the .4 pounds actual ingredient per acre rate if billbugs are the primary target (there should be enough residual to kill black turfgrass ataenius and the normal annual grub species that arrive in July), and MACH 2 labels now recommend using 2 pounds actual ingredient per acre.

Curative control of bluegrass billbugs in mid- to late June is difficult at best. The only product that remains as a potential billbug curative control is carbaryl (Sevin). In the past, we've had isophenfos (Oftanol) and isazofos (Triumph) but neither is currently available. Many turf managers claim success by using trichlorfon (Dylox), but billbug larval control is not on the existing labels.

For hunting billbug control, the recent research from Arkansas (Young & Musick, personal communication) suggests that the majority of the adults are active from late March through July, but adult females may be laying eggs from April into mid-October, so an application of an insecticide that kills the adults or the early stage larvae during April through June should provide protection from the damage observed in the subsequent winter months or the next spring.

It's my experience that imidacloprid applied during this time has eliminated much of the hunting billbug damage observed on tee banks and bunker slopes. One might consider making this application at the time that mole cricket eggs are hatching or the annual white grubs are laying their eggs to reduce the populations of these insects at the same time.

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Fall Pre-emergence Weed Control

As we approach late summer, superintendents need to start reviewing and deciding on their program of products for Fall pre-emerge. An effective pre-emergence program is one of the major objectives of superintendents across the country, especially in the South. The key in selecting the appropriate pre-emergent product is to determine the target weeds you are going after, whether *Poa annua* or other annual broadleaf weeds such as henbit, chickweed, or knotweed.

Following is a list of factors the golf course superintendent should consider when selecting the best product and program for fall and winter preemergence weed control:

Climate

- This will effect the timing of the application as soil temperatures not only vary by region of the country but it can be significant within a state. Apply too early and you sacrifice control later in the season; too late and you miss the early germinating weeds.
- The average amount of rainfall within an area will determine the rate and/or frequency of application. In general, higher precipitation during the late fall/winter will require higher rates and/or multiple applications of pre-emergent herbicides. It is recommended that in Southern climates with higher rainfall, mid-winter treatments are required to achieve acceptable season long weed prevention.

Chemical properties

- There are differences in pre-emergent chemicals that relate to microbial breakdown, photodecomposition by sunlight, volatilization and phytotoxicity.
- Consideration must be given to the chemical water solubility and the strength of its adherence to the soil. As an example, Prodiamine (Barricade) has low solubility so an earlier application would be required.

Single or split application

- The decision on this factor will determine the rates the pre-emergent product is applied and the length of weed control that is desired.

Particles Per Square Inch Matrix

POUNDS/ACRE	SNG 80	SNG 100	SNG 125	SNG 150	SNG 175	SNG 215	SNG 240	SNG 300
100	15.0	7.7	3.9	2.3	1.4	0.8	0.6	0.3
125	18.7	9.6	4.9	2.8	1.8	1.0	0.7	0.4
150	22.5	11.5	5.9	3.4	2.1	1.2	0.8	0.4
175	26.2	13.4	6.9	4.0	2.5	1.4	1.0	0.5
200	30.0	15.4	7.9	4.5	2.9	1.5	1.1	0.6
225	33.7	17.3	8.8	5.1	3.2	1.7	1.2	0.6
250	37.5	19.2	9.8	5.7	3.6	1.9	1.4	0.7
300	45.0	23.0	11.8	6.8	4.3	2.3	1.7	0.9

Avg. SG (g/ml) = 1.8

SGN represents particle size in millimeters x 100. Chart data is based on 45 lbs per cubit foot.

University tests show that small particle granular formulations offer weed control equal to or better than sprayable formulations.

University tests also show that small particle formulation provide a higher level of weed control over time than larger particle formulations.

Product coverage

- A key factor in achieving good weed control is selecting products that provide sufficient particles per square inch (PPSI). Pre-emergent herbicides such as Dithiopyr (Dimension), Pendimethalin (Pro Pendi) and Prodiamine (Barricade) exhibit strong adherence to the soil. It is therefore critical when using these pre-emergents to focus on products that are formulated on smaller particles providing more particles per square inch (PPSI) for better weed control.

Andersons offers a wide array of pre-emergence herbicides. Our pre-emerge are combined with inert carriers, and are offered in 80 and 100 SGN sizing. Our fertilizer + pre-emerge products are offered in 125, 150 and 215 SGN sizes. The product rates we recommend are based on providing sufficient particle coverage for good pre-emergence weed control.

The Andersons formulate Barricade, Dimension, ProPendi, Ronstar, Bensulide, Siduron and Team preemergence herbicides. When you use one of the Andersons pre-emergent herbicides, you can be assured that you will get the best product on the market and achieve the weed control you desire. The Andersons have set the pace in the turf industry when it comes to fertilizer and fertilizer combination products. Particles per square inch (PPSI), Size guide number (SGN), uniformity, consistency, quality, and results are synonymous with the Andersons Professional products. See and experience the Andersons Advantage for yourself.

Article contributed by Mark Wiesepape, territory manager for Northern Texas, Oklahoma and Arkansas.

New Tools Promise Help In Dollar-Spot Battle

By Nathan R. Walker

Dollar spot is an invasive and destructive disease of many turfgrasses, especially creeping bentgrass used on putting greens. It's a persistent disease frequently encountered by turfgrass managers, and for that reason more money has been spent to suppress dollar spot than any other turfgrass disease (Vargas, 1994).

Unfortunately, many frustrated turfgrass managers have encountered fungicide-resistant strains of dollar spot that are not effectively controlled by current fungicide chemistries. The presence of resistant strains has resulted in reliance on protectant fungicide chemistries, which need to be applied frequently and usually at greater expense than fungicides with long residual activity.

Due to the notorious nature of dollar spot, any new advance in its control will be of great interest to the turfgrass pest management community. Recently, BASF Corp. discovered a new type of fungicide chemistry known as boscalid, which is extremely effective at managing dollar spot. Boscalid, under its proposed trade name Emerald, has systemic properties within the plant and is effective at inhibiting most dollar spot growth stages. Emerald inhibits a specific and vital metabolic pathway within fungal cells. More specifically, this system is referred to as the complex II within fungal mitochondria. Emerald, however, is different in that the mode of action and the metabolic site it affects are not the same as strobilurins and all other turfgrass fungicides currently on the market.

The product with the most similar (but not identical) mode of action on the shelf today is flutolanil (ProStar) in the carboximide family. ProStar does not have significant activity against dollar spot, however.

Although Emerald is not currently available on the market, its name is recognized by many superintendents because it has been evaluated for activity against dollar spot in numerous field studies conducted by university personnel across the United States. In these trials selected to evaluate its performance, Emerald performed well under a variety of conditions and environments. In cooperation with superintendents, Emerald has also been evaluated under real-world conditions at U.S. golf courses with excellent results against dollar spot, including those locations which have historically difficult to control or resistant dollar spot, such as Atlanta Athletic Club (Duluth, Ga.) and Woodholme CC (Pikesville, Md.).

As dollar spot spreads across the country, superintendents are looking for new tools to battle it.

When evaluated in trials conducted at Oklahoma State University in 2002, conditions were established to encourage dollar spot on creeping bentgrass. The creeping bentgrass cultivar SR 1020 was selected for disease susceptibility, and irrigation was used to encourage dollar spot incidence and severity. In addition, the research area was not treated with fungicides during the previous dollar spot outbreak to ensure a high incidence and uniform appearance of the disease the following spring. All of these measures were taken to evaluate the performance of materials when challenged by the most severe dollar spot disease pressures.

Fungicides were applied to the turf using a carbon dioxide (CO_2)-pressurized (40 pounds per square inch) wheelbarrow sprayer

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equipped with TX8008 flat fan nozzles and calibrated to deliver 2 gallons per 1,000 square feet. The turf was mowed at a height of .16 inches six days a week, and applications were conducted at 14-, 21-, and 28-day intervals.

Treated turfgrass was rated for quality because dollar spot lesions can range from large, sunken patches to small flecks.

Emerald was also included in a rotation program with another BASF experimental fungicide, Insignia (pyraclostrobin). Each product was alternately applied on a 14-day interval.

The number of dollar-spot diseased areas, and the overall quality of the turfgrass, was evaluated weekly until disease subsided, which typically occurs in late June.

Emerald applied at .13 ounces per 1,000 square feet provided fast and excellent suppression of dollar spot throughout the study (Figure 1). Disease suppression by Emerald was also evident when the applications were made every 21 or 28 days.

For example, when Emerald was applied every 21 days at .13 ounces per 1,000 square feet, almost no disease was detected at the end of the study. Likewise, when Emerald was applied every 28 days at a higher rate, .18 ounces per 1,000 square feet, very little disease was present in the treated areas.

When Emerald was rotated with Insignia at .9 ounces per 1,000 square feet and applied every 28 days at .13 ounces per 1,000 square feet, a similar reduction in dollar spot was also observed.

In contrast, disease severity during the evaluation period continued to increase for turfgrass treated with one of the newer chlorothalonil products applied every 14 days at 3.2 ounces per 1,000 square feet or when not treated at all by a fungicide.

The treated turfgrass was also rated for quality because dollar spot lesions can range from large, sunken patches to small flecks. To evaluate turfgrass quality, a rating scale was used where 1 equalled thin, discolored turf and 10 equalled thick, healthy desirable turf. When rated for quality, Emerald treated turfgrass was equally impressive (Figure 2).

Turfgrass treated with Emerald on a 14-day interval received a quality rating of 9.75. When the application interval was lengthened, quality ratings ranged from 9.88 for Emerald applied every 21 days to 9.63 for the 28-day interval. The turfgrasses treated with the newer chlorothalonil received a quality rating of 7.75, and the nontreated areas were rated a poor 5.5.

In addition to superb dollar spot control, Emerald has demonstrated excellent activity

FIGURE 1

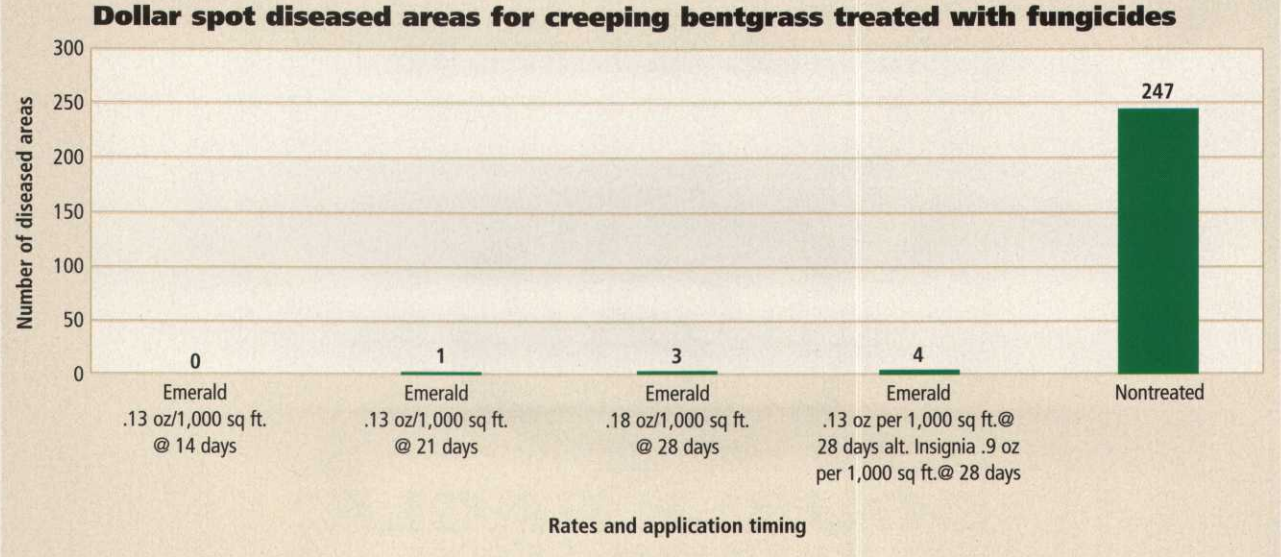
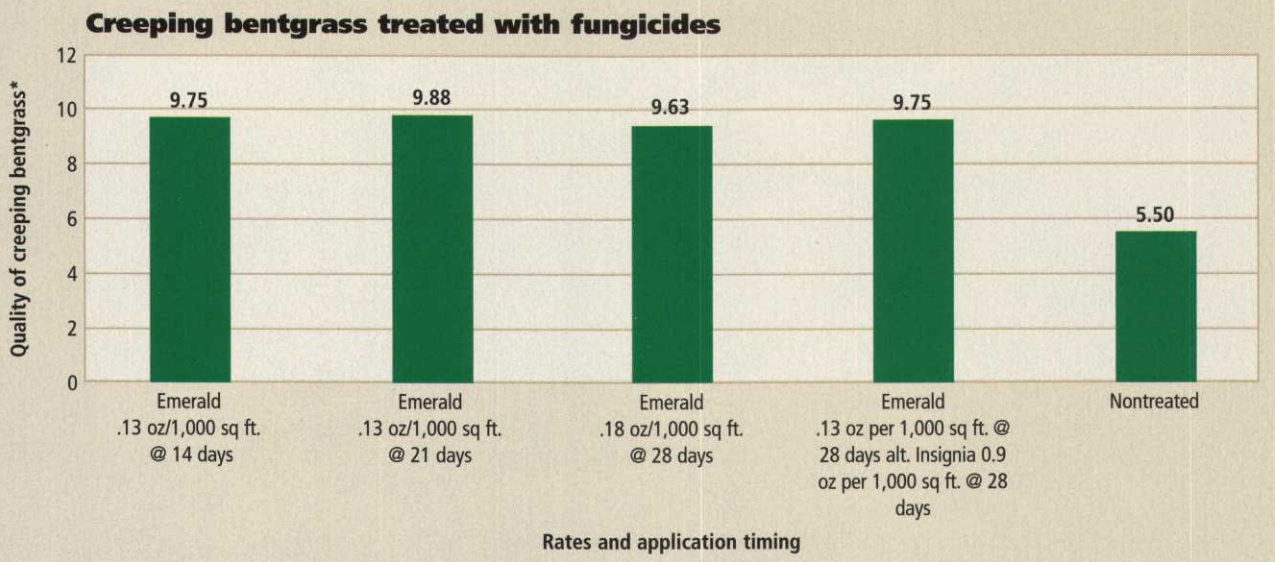


FIGURE 2



*Evaluated on a rating scale where 1 = thin, discolored turf and 10 = thick, healthy desirable turf

against a new disease, bentgrass dead spot, caused by Ophiosphaerella agrostis. In a limited number of field trials conducted over the last few years, Emerald appeared to work well against this emerging disease.

The excellent activity of Emerald against dollar spot has great implications for disease management programs. It is a new class of chemistry and is effective against dollar spot isolates, which are resistant to benzimidazoles, dicarboximides, and DMI (sterol-inhibiting) fungicides.

In addition, because Emerald is systemic within the plant, it can be used prior to the onset of disease or after disease symptoms have begun to appear.

Turfgrass managers can feel free to rotate to any different class of chemistry when managing disease because of Emerald's unique mode of action. Even though Emerald belongs to the same chemical family as ProStar, there is no reason to suspect that the inclusion of both Emerald and ProStar in disease management programs will have any negative impact on turfgrass disease management programs.

Due to the disease suppression by Emerald and the remarkable ability of the dollar spot causal agent for developing resistance to fungicides, there are concerns about future, exclusive reliance on this new chemistry for dollar spot management.

To limit the selection of isolates less sensitive to Emerald, no more than two consecutive applications of Emerald should be permitted. Once two applications of Emerald have been made, superintendents must rotate to another fungicide labeled for dollar spot before reapplying Emerald.

The great interest in Emerald has many turfgrass managers asking when can they expect to see Emerald reach the market. Emerald is undergoing an expedited review by the EPA, and BASF Corp. expects registration later this year. Emerald will be available as a 70 percent water dispersible granule and will be labeled for use on golf course turfgrasses for dollar spot and bentgrass dead spot management at the rate of .13 ounces to .18 ounces per 1,000 square feet.

As with any new product, there is, and will continue to be, great interest in Emerald. Its toxicity profile, specificity, unique mode of action and effectiveness will allow Emerald to be adopted into turfgrass-integrated pest management programs when the product becomes available on the market.

Walker is an assistant professor in the Department of Entomology and Plant Pathology at Oklahoma State University. His specialty is turfgrass integrated pest management and turfgrass pathology.

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QUICK TIP

Billbug larvae, not adults, cause most of the damage by feeding in the stems and crown of the turfgrass plant. Older insecticides relied upon controlling billbug adults in early spring, prior to egg lay or larval emergence. Preventive applications of Merit will control the damaging larval stage because of Merit's systemic activity within the plant.