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IN THIS ISSUE

Bermudagrass Decline Increasing?

James B Beard

Major problems have occurred with Tifdwarf hybrid bermudagrass (*Cynodon dactylon* x *Cynodon transvaalensis*) putting greens in the southern and southeastern regions of the United States. Much of the summer was characterized by an extended drought period followed by very intense rainfall in the latter part of the summer. The problem has been attributed to bermudagrass decline caused by *Gaeumannomyces graminis* var. *graminis*. There have been difficulties in bringing the problem under control. As with many stresses, the problem is probably a combination of waterlogged soils, high atmospheric humidities, high temperatures and a causal pathogen, assuming the diagnosis that has been made is correct.

Bermudagrass decline attacks primarily the roots. Visual symptoms first appear as a rotting of the roots. There are no lesions visible on the leaves, with the older, lower leaves gradually becoming chlorotic and senescing. The shoots then turn to dark-brown followed by a serious thinning of the turf in non-distinct patches ranging from 0.5 to 3 feet (0.15 to 1 m) in diameter. These patches may coalesce to form larger, irregular-shaped areas. Bermudagrass decline typically appears in late summer through late autumn or in early spring, and is most severe during periods of intense rainfall on closely mowed putting green turfs.

Cultural controls should include practices that will encourage regrowth of the root system. This includes moderate nitrogen levels and high potassium levels, possibly by weekly foliar feeding; plus raising of the cutting height. **It also is important to maintain a positive plant water balance, usually through timely manual watering of the patches as visual wilt of the leaves occurs.** This is because the turf is especially prone to drought stress due to the lack of a root system. There are no known bermudagrass cultivars that are resistant to the causal pathogen of bermudagrass decline. Some turfgrass pathologists indicate that there are no preventive or curative fungicide treatments that are effective. Others are of the opinion that bermudagrass decline can be brought under reasonable control via the use of triadimefon (Bayleton® 25WP). **It should be noted that the pathogen attacks the root system first and that it is at this time that the application of a fungicide probably would be most effective.** The actual thinning and loss of the aboveground grass shoots may occur at a later time during periods of atmospheric water stress. Obviously, more research needs to be conducted concerning the *Gaeumannomyces* pathogen on bermudagrasses.

Seeding Rates Based on Cultivars

Dr. James B Beard

In the past 100 years the seeding rates of turfgrasses have been based on the individual species. This approach has resulted in acceptable turf establishment for the most part. However, significant changes have occurred that open the door for a new approach in selecting seeding rates.

Numerous turfgrass cultivars are available within a number of turfgrass species. This has resulted in a wide range in the number of seeds per pound among cultivars within certain species (see Table). **For certain species the range in seed number per pound can be two- to three-fold.** Examples include Kentucky bluegrass (*Poa pratensis*), tall fescue (*Festuca arundinacea*), perennial ryegrass (*Lolium perenne*), certain fine-leaf fescues (*Festuca rubra*), and Japanese zoysiagrass (*Zoysia japonica*). **These wide differences emphasize the need to adjust the seeding rate in relation to the specific cultivar of certain turfgrass species.** While favorable moisture and temperature conditions during the seed production period can result in a somewhat higher seed density with a lower number of seeds per pound, this potential variation is not nearly as significant as the variation that now exists among cultivars within certain turfgrass species.

Why the need to adjust the seeding rate in relation to the seed number factor for various turfgrass cultivars? Typically, excessively high seeding rates can create problems. The most successful planting rate in assuring rapid, uniform turfgrass establishment consists of **applying an approximate number of seeds per square inch equal or to slightly lower than the ultimate number of shoots per square inch of the mature turf for the turfgrass species involved.** For many cool-season turfgrasses mowed at a height of 1.5 inch (38 mm) the shoot density usually is in the range of 10 to 25 shoots per square inch. Excessively high seeding rates result in stunted growth, involving a high density of spindly, weak seedlings that tend to remain in a juvenile state for an extended period of time. This means there is a lack of rooting, tillering, and lateral stem development, such as rhizomes and stolons, needed to form a mature sod that has maximum tolerance to traffic, environmental, and pest stresses. Many seedlings will have to die in order to allow adequate space and quantities of light, moisture, and nutrients so a select few of the plants can mature to a fully tillered state with the desired lateral stem development. Thus, **although a very high seeding rate results in a more rapid green appearance, the rate at which a mature, stable turf is formed can be substantially slower than when using a more appropriate, lower seeding rate.**

There also is the question of using seeding rates lower than the norm. This depends on the particular turfgrass species involved. Selecting the appropriate seeding rate is particularly critical for turfgrass species with a bunch-type growth habit, such as tall fescue, Chewings fescue and the ryegrasses, as they do not possess the ability to grow laterally via rhizomes and/or stolons. In contrast, those species with a creeping growth habit via rhizomes or stolons can be planted at much lower seeding rates and in time can still form a quality, dense turf. The principal problem with using the low seeding rates is that a longer establishment period results in a greater likelihood of significant weed problems developing in the interim. Also, a thin turf canopy that allows sunlight to reach the soil surface results in greater temperature extremes and more rapid drying of the soil surface, thereby increasing the amount of environmental stress on the isolated seedlings via either heat kill or desiccation.

The final question is how to calculate the appropriate seeding rate for a cultivar? Assuming you know the seed number per pound for the particular cultivar to be planted and a desired number of seeds per square inch has been determined, the following formula can be used to calculate the seeding rate in pounds per 1,000 square feet:

$$\frac{\text{seed number desired per in.}^2 \times 144{,}000}{\text{seed number per lb}} = \frac{\text{seeding rate}}{(\text{lbs per } 1{,}000 \text{ ft}^2)}$$

TURFGRASS SEEDING RATE GUIDELINES

Turfgrass Common Name	Number of Seeds per Pound (thousands): Cultivar Range[b]	Mean	Seeding Rates[a]: lb/1,000 ft²	lb/A[c]	seeds[c] per kg/ha	in.²
Bahiagrass	166 – 272	219	5.5 – 8.0	240 – 348	269 – 389	8.4 – 12.2
Bentgrass:						
colonial	5,000 – 8,720	6,860	0.5 – 1.0	22 – 44	25 – 49	23.8 – 47.6
creeping	4,887 – 7,937	6,412	0.5 – 1.0	22 – 44	25 – 49	22.5 – 45.0
velvet	8,000 – 11,800	9,900	0.3 – 0.7	13 – 30	15 – 34	20.6 – 48.1
Bermudagrass (hulled)	1,400 – 2,200	1,800	1.0 – 1.5	44 – 65	49 – 73	12.6 – 18.7
Bluegrass:						
creeping annual	1,700 – 2,300	1,900	1.0 – 1.5	44 – 65	49 – 73	13.3 – 19.7
Kentucky	800 – 1,900	1,350	1.5 – 2.0	65 – 87	73 – 97	14.0 – 18.7
rough	2,093 – 2,655	2,874	1.0 – 1.3	44 – 56	49 – 63	16.6 – 21.2
Buffalograss, American	40 – 56	48	1.5 – 2.5	65 – 110[d]	73 – 123	0.5 – 0.8
Carpetgrass, common	1,124 – 1,250	1,187	1.5 – 2.0	65 – 87	73 – 97	12.3 – 16.7
Centipedegrass	410 – 876	643	0.5 – 1.0	22 – 44[d]	25 – 49	2.3 – 4.5
Fescue:						
Chewings	365 – 535	450	4.5 – 7.0	196 – 305	219 – 342	14.1 – 21.9
creeping red	270 – 430	350	5.5 – 9.0	240 – 392	269 – 439	13.4 – 21.9
hard and sheep	420 – 930	675	3.0 – 4.5	131 – 196	148 – 220	14.1 – 21.1
meadow	226 – 230	228	7.0 – 9.5	305 – 414	342 – 464	11.1 – 15.0
tall	140 – 238	189	7.5 – 11.0	327 – 479	367 – 536	9.8 – 14.4
Grama, blue	850 – 900	875	1.5 – 2.5	65 – 110	73 – 123	9.1 – 15.3
Ryegrass:						
annual	190 – 230	210	8.0 – 11.0	390 – 479	341 – 536	13.1 – 16.0
perennial	140 – 390	265	7.0 – 10.5	305 – 457	342 – 512	12.9 – 19.3
Wheatgrass, fairway						
crested	190 – 350	270	4.5 – 5.5	174 – 240	195 – 269	7.5 – 10.3
Zoysiagrass, Japanese	862 – 1,652	1,257	1.5 – 2.5	65 – 109	73 – 122	13.1 – 21.8

[a] Where seed mixtures are utilized, the appropriate adjusted intermediate seeding rate should be used, based on the relative percentages of the various turfgrass species used.
[b] Among cultivars, the seed number can vary depending on the cultivar.
[c] Based on a mean of the two extremes in seed numbers listed in the third column.
[d] The very low seeding rate is due to high seed cost.

FEATURE ARTICLE

Moss on Bentgrass Putting Greens—An Increasing Problem

Fred Yelverton

The occurrence of mosses on bentgrass (*Agrostis* spp.) putting greens is increasing in many areas of the United States. Moss on bentgrass greens is not a new problem. However, **most areas of the country are reporting the incidence of mosses is increasing at an alarming rate.** Even areas with warm and sunny climates, such as southern California and the southern United States, are experiencing substantial increases in moss problems.

Golf course superintendents are asking the logical question, Why is it increasing? The answer is, Nobody knows for sure. However, a review of moss history and changes in bentgrass cultural practices may provide some insight.

Mosses are very primitive plants. They are not higher plants like our turfgrass species or weeds. Their life cycle and morphological characteristics differ dramatically from those of higher plants. For instance, **mosses do not have roots; they have specialized structures called rhizoids that basically function to anchor the plants to a surface.** You may have noticed that mosses do not necessarily grow in or on soil. It is not unusual to see them thriving on walkways, bridges, rocks, and even vertical walls. **Most mosses also lack a true vascular system, a fact that makes control exceedingly difficult.** Another problem is that very little is known about moss biology and ecology. There are only a very few scientists in the world that study these plants.

Mosses are characterized as primitive survivors. Fossil records date back to between 360 and 438 million years ago. As a reference point, dinosaurs first appeared about 248 million years ago and were extinct 144 million years ago. Other primitive organisms that are still around today include cockroaches, opossums, alligators, and sharks. These organisms, including mosses, have survived because they are highly adaptable. **Mosses have traditionally been associated with a low intensity of management, low-pH soils, dense shade, and wet soils. Their ability to adapt to and survive in putting green conditions is remarkable.**

Changes in bentgrass cultural practices may have contributed to the increased invasion of mosses. Mosses are very opportunistic plants and generally do not survive very well when the turf is highly competitive. **A trend toward lower mowing heights on bentgrass greens is generally regarded as one of the reasons that mosses are increasing.** Moss often is observed to invade and be most acute in areas of the green that are prone to scalping, such as on acute changes in slopes or mounds. Another potential contributing factor may be the discontinued availability and use of mercury-based fungicides. Mosses are sensitive to many heavy metals. In my research, I have examined the effects of these older products and have had good suppression of moss. The newer fungicides available today appear to have little if any activity on moss.

There has been some research conducted on management of mosses in bentgrass greens. However, look for research activity to increase due to the increase in moss incidence. One of the first objectives is to properly identify the moss species. **There are approximately 9,500 species of moss, but only a very few have been identified on bentgrass greens. The most common thus far is silvery thread moss (*Bryum argenteum*).** A thorough understanding of the biology and ecology of this plant will be necessary if successful control strategies are to be found.

FEATURE ARTICLE

Five Tips for Better Cutworm Control

Daniel A. Potter

The black cutworm (BCW), *Agrotis ipsilon*, is a major pest of creeping bentgrass (*Agrostis stolonifera*) putting greens, tees, and even fairways. BCW larvae dig a burrow in the thatch or soil, or occupy coring holes or other cavities, emerging at night to chew down the grass blades and stems around the burrow. The resulting dead patches and sunken pockmarks, which resemble ball marks on putting greens, are a familiar headache for nearly every golf superintendent. Infestations attract foraging birds, which pull up tufts of grass, further damaging surface quality.

My former student R. Chris Williamson (Ph.D., 1997) and I recently completed a 3-year, USGA-funded study of BCW biology and management on golf courses. This research yielded much insight on the habits of cutworms, some of which can immediately be put to use by golf superintendents.

Tip #1: Avoid emptying mowing baskets or strewing clippings beside putting greens or tees. Female BCW moths laying eggs on close-cut creeping bentgrass putting greens or tees nearly always glue their eggs near the tips of grass blades. Our research showed that about 80-90% of the eggs are removed with the clippings each time the turf is mowed. Many of these eggs survive passage through the mower blades, hatching in a few days. Resulting larvae that develop in the surrounding rough may later reinvade the close-cut bentgrass areas. To reduce incidence of reinfestation, dispose of bentgrass clippings well away from putting greens.

Tip #2: When treating for BCW, include a buffer zone around putting greens and tees. If mowing removes most of the eggs, where do the large BCW that damage greens and tees come from? BCW moths also lay eggs in fairways and roughs, and populations may build up in such areas. As the larvae become larger, they crawl about at night and may be attracted to the moist soil and lush bentgrass of putting greens and tees. By mapping larval tracks left in the dew, we confirmed that many of the BCW that damage putting greens originated from approaches and surrounding roughs. Larger cutworms were observed to crawl as far as 50 feet (15 m) across putting surfaces in a single night! Thus control actions for BCW should consider the reservoir population as well. Treating a 20 to 30 foot (6–9 m) buffer zone around putting greens, and a proportionately smaller zone around tees, may reduce reinfestations by crawling larvae.

Tip #3: Use sprayable formulations, and treat late in the day. Don't water the insecticide in, and withhold irrigation at least until the following morning. Treating late in the day minimizes loss of activity from photodegradation and volatilization, ensuring that the BCW will encounter fresh residues as they feed on the foliage after dark. Treating late in the day also reduces exposure to golfers until the residues have dried.

Tip #4: Sample for spray timing, and to assess effectiveness of treatments. Sampling for BCW is easy and can help you to get a jump on a developing infestation. Add about 1 oz—or 2 tablespoons (30 mL)—of lemon-scented Joy® dishwashing liquid to a 2-gallon pail of water, stir gently to minimize sudsing, and pour the solution over a 3 x 3 ft area (0.8 m^2) of turf. Any BCW that are present will surface within a minute or two. Armyworms, sod webworms, mole crickets, black turfgrass ataenius adults, or other pests also may be flushed out. Optimal timing is when most of the larvae are still small, i.e., 1/2" (12.5 mm) or less. Sampling a day or two after treatment is useful to confirm that control was achieved.

Tip #5: Consider the newer products. Pyrethroids such as bifenthrin (Talstar®), cyfluthrin (Tempo®), deltamethrin (Deltaguard®), and lamda-cyhalothrin (Scimitar®) are especially effective against BCW. Most pyrethroids are highly toxic to fish, so use special care around ponds, or wherever runoff may occur. Halofenozide (Mach2®) and spinosad (Conserve SC®) also will provide good control. Products containing entomopathogenic nematodes have shown promise against BCW; however, performance of the fungal-based insecticide Naturalis-T (*Beauveria bassiana*) has been erratic.

This article was adapted from information in the author's new book Destructive Turfgrass Insects: Biology, Diagnosis, and Control, *which is available from Ann Arbor Press.*

Invasion of Alien Plants

Don Tolson

As land and resource managers, golf course superintendents are among the most environmentally responsible. Our integrated pest management programs include herbicide use as a last choice. With all the attention focused on environmental responsibility and awareness, most golf course superintendents are thinking of ways to reduce or eliminate herbicide use.

Invasion of Alien Plants! Doesn't it sound like a great title for a Steven Spielberg movie?

Most of us have a weed management plan in our integrated pest management program to control undesirable turfgrass weeds, such as dandelions (*Taraxacum* spp.), clover (*Trifolium* spp.), chickweed (*Cerastium* and *Stellaria* spp.), etc. The plan includes (a) a well balanced nutritional strategy to maintain a dense, healthy turf, (b) proper water management, and (c) the selective, responsible use of herbicides as a last resort.

As land managers, superintendents have more than bluegrass (*Poa*), bentgrass (*Agrostis*) and flowers to manage. Most golf courses have from a few to a few hundred non-turf acres which are part of the golf course property that usually are under our management. **Noxious weed control on those non-turf acres is almost always our responsibility.** Too frequently the control of these very destructive, nonnative plants is near the bottom of our priority list.

Financial and labor resources are almost never adequate to do a good job of off-course weed management. At the time of year when we need to be spraying Canada and musk thistle (*Cirsium* and *Carduus* spp.) and diffuse, Russian, and spotted knapweed (*Centaurea* and *Acroptilon* spp.), we are very busy mowing grass that is growing at warp speed, and cultivating greens, tees and fairways.

While we are busy keeping the green, and chemophobic environmental organizations such as the Northwest Coalition for Alternatives to Pesticides are marching to stop the use of herbicides on public lands, alien plants are devouring 4,500 acres (1,823 hectares) per day. During the late 1980s I watched noxious weeds like knapweed, leafy spurge (*Euphorbia esula*), and thistle get a toe-hold along public roads in our national forests, along rivers and streams that I frequently fished, and on my non-irrigated acres at The Yellowstone Country Club. Each summer I go back, and **despite the most aggressive and comprehensive noxious weed management program in the West, Montana has lost over 4 million acres (1.6 million hectares) to spotted knapweed (*Centaurea maculosa*) alone.**

At Fox Hollow, Lakewood, Colorado, we have 250 non-turf acres (101 hectares). Many of these acres have been designated as high-quality wildlife habitat and environmentally sensitive. Golfers must stay out. In 1992 through 1994 we spent as much time as possible in mechanical removal of knapweed and thistle. In 1995 we implemented a selective herbicide spray program, combined with mechanical removal, and have stepped up the acres sprayed each spring.

By the 4th of July, 1997 I decided we were losing ground at an alarming rate. After seeking help from weed control specialists Kevin Galligher of Cornbelt Chemical and Jim Lyle, Jefferson County Noxious Weed Control Coordinator, we are **developing a new "Noxious Weed Management Plan."**

We have learned that (a) spring is not the only time to effectively eradicate these weeds, and (b) better long-term control results can be obtained with wiser herbicide choices.

We still have lots to learn at Fox Hollow, but come autumn we will be ready to fight the "Invasion of Alien Plants."

Pigs Rooting in Europe!

Dr. James B Beard

A major problem on North American turfs, particularly those near ponds and lakes, is excessive populations of Canada geese, which destroy turfgrasses and leave large areas covered with slimy excrement. A distinctly different problem has been on the increase in Europe for some time.

Specifically, it involves the destructive rooting damage of wild pigs (Suidae family) on turfgrass areas. In earlier years many of the natural habitats for wild pigs were areas where families with low incomes tended to live. Thus, hunting for pigs was an inexpensive source of meat. The killing of wild pigs became so intense that many countries enacted laws to protect what was considered an endangered species at the time. Now times have changed. Economies in many of these regions have improved such that hunting wild pigs as a source of meat has greatly declined. Subsequently, the wild pig population has exploded without this hunting pressure. While there are now large populations of wild pigs, the protectionist laws are still in place. Consequently, the wild pigs are moving out of their normal habitat onto turfgrass areas.

The problem extends from southern Europe up through Berlin, Germany. The use of irritants and similar approaches have not been successful in preventing turf damage by the nocturnal rooting of wild pigs. A single night's activity with a group of wild pigs can result in acres of fairway turf being destroyed. At least one golf course was actually closed to play due to destruction of the playing surfaces by wild pigs. The only approach that has proven effective in preventing turf damage by wild pigs has been the very costly installation of a perimeter chain-link fence. It appears that the problem may continue to increase on golf courses in Europe, particularly during dry summers when the population of wild pigs exceeds the ability of the adjacent natural habitat area to support these animals. Thus they tend to move onto the irrigated turfs of golf courses, sport fields, lawns, and gardens.

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JB COMMENTS

Types of Hydrophobicity Must be Considered

There is a need to change current thinking concerning hydrophobic turf-soil problems. The concept in the past has been to consider this problem as one single entity and to employ cultural-management strategies accordingly.

Actually there are at least three different types of hydrophobic problems associated with turf-soil situations. One problem is (a) **hydrophobic dry patch** caused by constituents from the mycelia of soil basidomycetes coating the soil-sand particles to create a relatively severe hydrophobic condition. The symptoms typically evolve initially as distinct patches. They are most common on high–sand content root zones. Other problems are (b) **general soil surface hydrophobicity** associated with a shallow surface layer of higher soil organic matter content in the upper soil profile, and (c) **turf thatch** of sufficient density and depth that a hydrophobic condition develops. The thatch may be partially decomposed, but usually has no intermixed soil present.

Typically, one of the more effective means of treating these various types of hydrophobicity has been the use of certain effective wetting agents. **Evidence is starting to evolve that certain wetting agents may be effective only on one or two of the three major types of hydrophobicity just listed.** It's possible that other cultural practices related to the prevention or control of these types of hydrophobicity also may vary by type. Thus the need in problem diagnosis to recognize that there are different types of hydrophobic turf-soil problems!

RESEARCH SUMMARY

Lawn Chemical Effects on Soil Organisms

Turfgrass growth is strongly interrelated with the health of the soil system, including its biological components. Questions have been raised about the effect of lawn chemical treatments on the biological components of turfgrass soils. An ongoing study is under way at Michigan State University to assess the biological status of soils that have received eight different commercial treatments typically used in lawn maintenance operations. The effects of these treatments were compared to an untreated control turf, plus an adjacent cropland area. Direct counts were made of bacteria and fungi using fluorescent microscopy and computerized image analysis, as well as assessments of carbon and nitrogen mineralization potentials and carbon-to-nitrogen ratios.

The first year data reveal that the turfed areas exhibited on the order of two to three times the mineralization potential for both carbon and nitrogen compared to that on adjacent cropland. Furthermore, **no significant differences in carbon and nitrogen mineralization potentials were found between the untreated turf plots and those that received various chemical lawn treatments which included an all-organic program.** This investigation will be continued in the coming year, with the monitoring of earthworm populations and the decomposition of organic matter being added to the assessment techniques. **By J.E. Ravenscroft, Jr., E.A. Paul, R.R. Harwood, and P.E. Rieke, Department of Crop and Soil Sciences, in 1998 Michigan Turfgrass Field Day Report. 22 pp.**

ASK DR. BEARD

Q *What should my strategy be in terms of cutting height during the late autumn period?*

A **Raising the cutting height during the last few weeks of growth prior to entering the winter dormancy period is beneficial for most turfs.** First, the higher cutting height allows greater leaf area to support photosynthesis and the production of carbohydrates to be accumulated for needed winter hardiness. The result is better tolerance to winterkill stresses such as direct low-temperature kill. The higher cutting height also provides carbohydrates needed to replace roots that may have been lost during the summer. Furthermore, the higher cutting height results in a greater aboveground canopy biomass, which functions as an insulation zone against direct low-temperature kill of the grass crowns and also reduces damage from winter traffic stress on dormant turfs, which have minimal recuperative ability.

A potential negative is allowing the grass to grow too high, so that it tends to lay over as a mat. In these situations the potential for winter diseases such as Typhula blight (gray snow mold) and Microdochium patch (pink snow mold) is increased.

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