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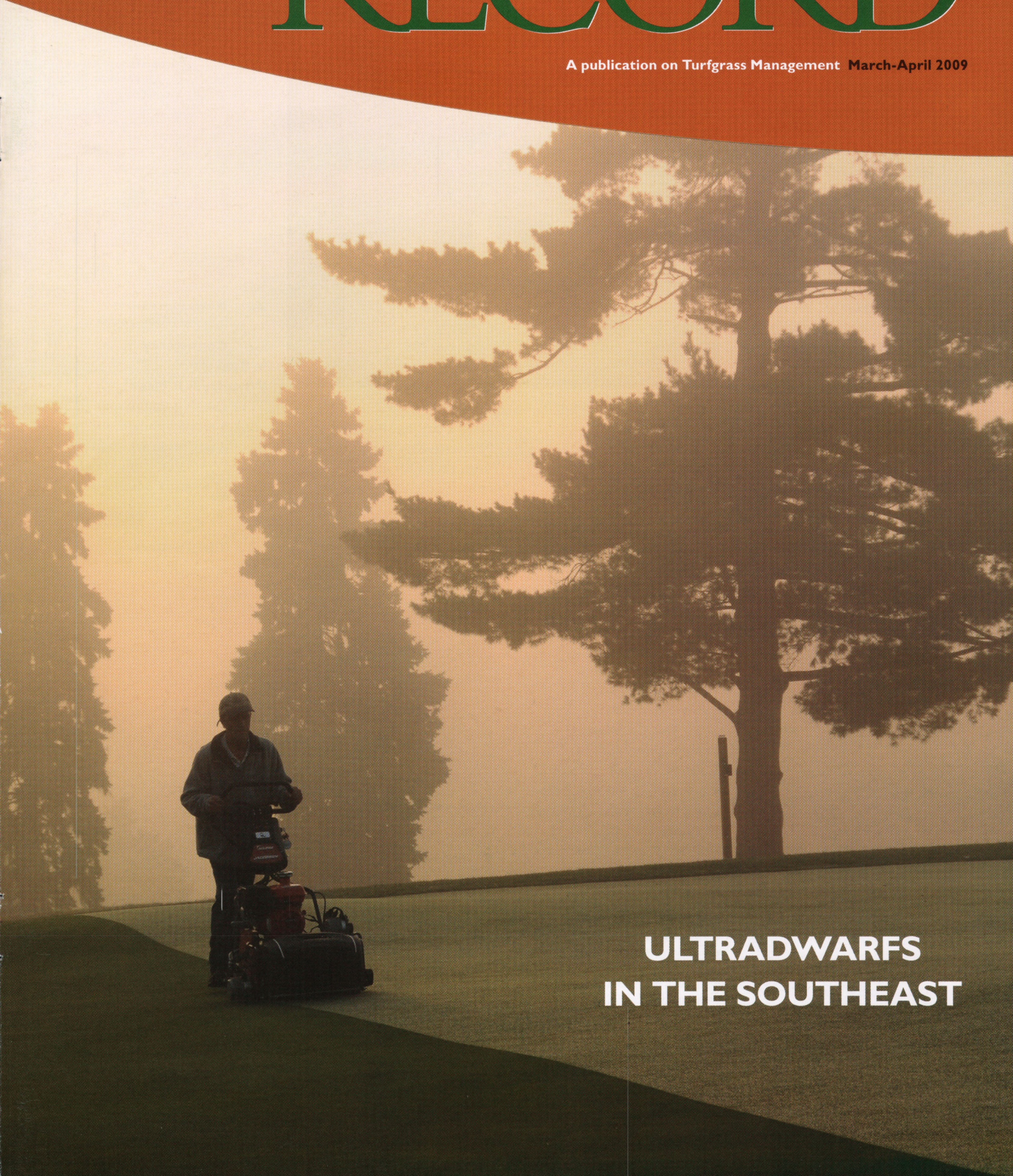

ULTRADWARFS IN THE SOUTHEAST

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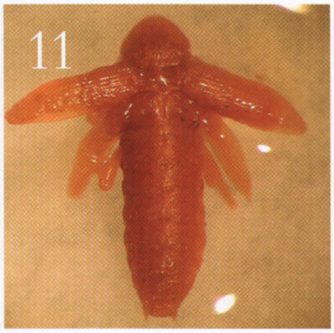

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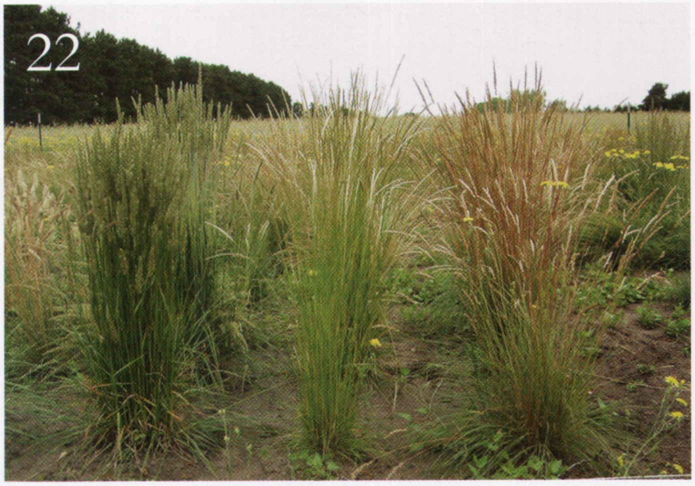

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Cover Photo
Ultradwarf bermudagrasses are breaking new ground in the Southeast.

THE HEAT IS ON

The first decade of the 21st century has seen ultradwarf bermudagrass varieties replacing bentgrass on putting greens in the Southeast.

BY CHRIS HARTWIGER

The motto of the Olympic games is "Faster, Higher, Stronger" (Citius, Altius, Fortius), but it could also apply to the selection of grasses on putting greens in the Southeast Region. Dating back to the early days of golf, the unique climate of the southern portion of the transition zone has never been an ideal fit for either bentgrass or bermudagrass for putting greens, nor has it excluded either species. The result has been an evolution of regrassing putting greens with improved grasses. The lineage roughly follows this pattern dating back to the early 1950s: common bermudagrass, Tifgreen, Tifdwarf, Penncross, more heat-tolerant bentgrasses, and ultradwarf bermudagrasses. Breeders develop the varieties, university researchers and superintendents perfect the management, and ultimately golfers determine which varieties come or go. And the process continues today.

The period since the early 2000s has seen the emergence of the ultradwarf bermudagrass varieties in the region. While the earliest adopters of the ultradwarfs were converting greens from Tifdwarf or Tifgreen, the period since 2005 has seen an acceleration in the number of courses removing their bentgrass putting greens and replacing them with ultradwarf bermudagrasses. Why is this occurring? There are several catalysts that led courses to consider and select ultradwarf bermudagrasses for their putting greens.

- Improved wear tolerance eliminates the need to overseed.
- Ability to peak the entire golf course at the same time. This is desirable for hosting important golf events in hot weather months.
- Management focus is shifted from multiple months of life support with bentgrass to a focus on playability.
- Fewer inputs (fans, fungicides, etc.) and fewer dollars spent compared to bentgrass for most courses.

The first courses to make the switch were ones that chronically struggled to keep bentgrass alive. They were not seeking perfection, simply wanting live grass by the end of the summer. The second wave is happening now, and they are the upper-end courses that desire to produce high-level golf conditions in the summer months. They want to provide the combination of higher green speeds and firmness that bentgrass greens cannot provide in the summer. The third group are courses looking to find a grass that meets golfer expectations on as low a budget as possible, and the ultradwarfs are filling this niche.

As the momentum of regrassing increases, superintendents face the challenge of learning the management of ultradwarf bermudagrass. Green committees and course officials familiar only with bentgrass need to be aware of the skills, tools, and maintenance calendar necessary to make ultradwarf successful. Fortunately, the early adopters and university researchers have helped hone the skills and practices necessary for success. We have learned that the method of management is just as important, if not more so, as the budget alone.

In addition to mowing, regular use of vertical blades to groom or lightly vertical mow is beneficial to surface quality over the long term. If vertical mowing is done too deeply, the healing time will be extended.

This article is dedicated to courses considering a change from bentgrass to ultradwarf in the transition zone. It is structured in two parts. The first part highlights the most common problems to avoid and solutions to assist, if these problems occur. The second part describes key practices that must be well executed to have a successful ultradwarf bermudagrass putting green.

PITFALLS TO AVOID

Overseeding

Problem: For decades, overseeding was a staple on Tifgreen and Tifdwarf bermudagrass putting greens, the goal simply being to provide a good putting surface in the winter and spring months. In most of the region, Tifgreen and Tifdwarf did not have the wear tolerance to provide an acceptable putting surface on courses with heavy winter and spring play. The downside of overseeding was and still is the significant disruption to the golf experience in the fall and during the transition in the spring. These courses become caught up in a late spring/early summer cycle of 1) fertilize heavily through June, July, and August to fill in bare areas after the overseeding died; 2) aerate heavily in midsummer to mitigate all the organic matter deposited by the overseeding and bermudagrass base; 3) fertilize heavily to recover from aeration; and 4) mechanically prep the greens for overseeding again in early fall. No wonder so many clubs jumped to bentgrass when pioneering superintendents proved they could keep bentgrass alive during the summer months!

This soil profile is now more than eight years old. The green was constructed using straight sand, and management was difficult until some organic matter had accumulated in the upper rootzone.

Solution: There are several reasons not to overseed an ultradwarf. The first one is its improved wear tolerance due to the more stoloniferous growth habit of ultradwarf grasses. Champion bermudagrass is a good example. Champion has 93 percent greater shoot density than Tifdwarf, and the number of stolons for Champion is 2.6 times greater than Tifdwarf and 2.8 times greater than Tifgreen (Beard and Sifers, 1996). A wear study showed Champion to be far more wear tolerant than Tifdwarf, with 32 percent more surviving green leaves and shoots than Tifdwarf after 1900 revolutions on a wear simulator (Beard and Sifers, 1996). In the field, all the ultradwarf bermudagrasses hold up well under winter play, assuming there are not compounding stresses such as shade.

A second reason not to overseed is nitrogen management. For overseeding to be successful, it is fertilized at a time of the year not beneficial for the bermudagrass base. All the nitrogen is not released during the overseeding period, and residual nitrogen released the next summer is likely to give the superintendent problems with unwanted growth.

A final reason to avoid overseeding is the elimination of shade, and details are included in the next section.

Shade

Problem: Whether sunlight is blocked by clouds, trees, or taller turf, reducing light quality and length will take its toll on ultradwarf bermudagrass. Too much shade will make it difficult, if not impossible, to produce desired conditions. The symptoms of excess shade are not hard to spot: thin turf that is not able to withstand and recover from stressful events, including golfer and equipment traffic, turf diseases, and routine cultural practices such as mowing, grooming, and core aeration.

Regular topdressing will smooth the surface and aid in dilution of organic matter.

Solution: Assessing how much shade is too much is difficult for golf course superintendents who are making the switch from bentgrass to ultradwarf bermudagrass. Although results from Dr. Grady Miller indicate that "TifEagle and Champion bermudagrass are capable of sustaining quality better than other dwarf grasses," superintendents converting from bentgrass to bermudagrass need to remember that bentgrass has better shade tolerance than ultradwarf bermudagrass (Miller and Edenfield, 2002). If shade is a problem on a bentgrass putting green, it is a given that the problem will be magnified with an ultradwarf putting green. However, there are sure to be other marginal areas where shade is likely to influence an ultradwarf putting green. What is a golf course to do? The following observations from the field and research results can help.

- Increase the quantity and quality of light a putting green receives through selective removal of trees. Dr. Bert McCarty and Todd Bunnell found that a minimum of eight hours of sunlight is required to provide acceptable turf quality in TifEagle bermudagrass in a Clemson research project (Bunnell and McCarty, August 2004). They also found that 12 hours of sunlight was optimal for an ultradwarf bermudagrass (Bunnell and McCarty, October 2004).
- There are situations where no more trees can be removed and sunlight is still limited. Bunnell and McCarty found that applications of the plant growth regulator Primo and an increase in mowing height improved the quality of TifEagle bermudagrass (Bunnell and McCarty, October 2004).

Extremes in Nitrogen Fertilization

Problem: Memphis Country Club has a reputation for some of the finest ultradwarf bermudagrass putting greens in the region. When discussing management strategies, Memphis Country Club superintendent Rodney Lingle commented that ultradwarf bermudagrasses are much more efficient users of nitrogen than their predecessors, Tifgreen and Tifdwarf. In other words, a little nitrogen goes a long way. This is confirmed in the field by far more frequent observations of mower scalping than lean, off-color putting greens.

Too much nitrogen is easy to identify because mower scalping will occur, and it can occur quickly. Many times an employee will report back to the maintenance facility that something must be wrong with the mower because it is scalping severely. Usually the mower is fine, but the growth of the grass has accelerated to the point of scalping. Mild cases of scalping can be detected on the downhill side of the mower pass when mowing on a slope.

Too little nitrogen is more difficult to identify. Typically, color will be poor, although if iron, magnesium, or manganese have been applied recently, color may not be the best indicator. Density may become more open, and there will be slower recovery from mechanical stress.

Solution: How much nitrogen to use each year depends on multiple factors, including rootzone

Plenty of leaf tissue, but few stems will be brought up when grooming or vertical mowing is done at the proper depth.

nutrient holding capacity, the length of the growing season, seasonal rainfall, and desired level of playability. Refer to the section on nitrogen management for details.

Poor Quality Water

Problem: Poor quality water is a major hurdle to anyone hoping to successfully manage ultradwarf bermudagrass. Elevated levels of sodium, soluble salts, and/or bicarbonates all can cause serious turf quality issues. Books have been written about the impact of water quality on turf, and if your golf course has poor water quality, careful study and analysis are needed before selecting an ultradwarf.

Solution: The most effective option to overcome poor water quality is to find a better water source for the putting greens, but this may not be possible in most cases. Because of the complexity of this topic and the constraints of space, a list of references for further study is noted below. In extreme cases, ultradwarf bermudagrass may not be sustainable and it may be advisable to consider seashore paspalum.

Carrow, R. N., M. Huck, and R. R. Duncan. 2000. Effective use of seawater irrigation on turfgrass. *USGA Green Section Record.* January/February. 38(1):11-17.

Carrow, R. N., M. Huck, and R. R. Duncan. 2000. Effluent water: Nightmare or dream come true. *USGA Green Section Record.* March/April. 38(2):15-29.

Carrow, R. N., M. Huck, and R. R. Duncan. 2000. Understanding water quality and guidelines for management: An overview of challenges for water usage on golf courses for the 21st century. *USGA Green Section Record.* September/October. 38(5):14-24.

Carrow, R. N., M. Huck, and R. R. Duncan. 2000. Leaching for salinity management on turfgrass sites. *USGA Green Section Record.* November/December. 38(6):15-24.

Carrow, R. N., and R. R. Duncan. 1998. Salt-affected turfgrass sites: Assessment and management. Ann Arbor Press, Chelsea, Mich.

Construction Issues: Straight Sand Rootzone and Variable Mix Depth

Problem: In this section there are two rootzone issues to deal with. Variable mix depth describes a condition in a single putting green where the depth of the rootzone mix varies significantly throughout the putting green cavity. The depth of the rootzone mix has a big impact on the amount of water that will be held at field capacity. The USGA Guidelines for Putting Green Construction recommend a rootzone of 12 inches. Deeper rootzone mixes have a higher gravitational head and will hold less water, thus being prone to droughtiness. Shallower rootzone mixes will hold more water and be prone to excess wetness. Both shallow and deep mix can exist in a single putting green, making water management difficult.

A second rootzone issue for ultradwarfs is a straight sand rootzone mix. Straight sands typically have low nutrient holding capacity (CEC) and low water holding capacity. Research at Clemson University on ultradwarf establishment in greensmixes with differing water holding capacity found that the length of establishment increased on a mix with a blend of 95:5 sand/peat mix compared to mixes with 85:15 sand/peat. This is confirmed in the field, as superintendents experience difficulty managing water and nutrients in straight sand or near straight sand rootzone mixes.

Solution: Variable mix depth must be dealt with through irrigation freqency and quantity. Absent rainfall, the two greatest influences on soil moisture are the uniformity of coverage by the irrigation system and the depth of the rootzone mix. It may be beneficial to conduct an audit of irrigation coverage and a study of rootzone depth for each putting green. Although time consuming, it is important to know the areas of the green that receive more or less water than desired and how they match up with shallower or deeper areas of rootzone mix. Set up irrigation cycles based upon the wettest areas on each green. It will be necessary to add supplemental hand watering to provide an appropriate amount of water for the ultradwarf plants.

The difficulty in managing a straight sand rootzone will become less over time, as more organic matter is deposited from plant growth. Some have achieved success by adding amendments to increase nutrient holding capacity.

Mechanical Injury

Problem: One of the go-to maintenance practices of Tifgreen and Tifdwarf bermudagrass varieties was an aggressive dethatching once or twice a season. The putting greens would appear destroyed, but with a shot of fertilizer, water, and warm weather, the putting greens came back thicker and denser than before. Ultradwarf bermudagrass varieties do not like this type of treatment at all, and they will rebel in the form of extended recovery and bumpy surfaces for several *months.* Research by Dr. Wayne Hanna of the University of Georgia showed that despite differing rates of nitrogen or plant growth regulator, aggressive dethatching required a minimum of at least six weeks of recovery. This is too much recovery time, given the requirements of play.

Solution: Aggressive dethatching is not advised. Refer to the section on surface management for alternatives.

KEY PRACTICES

With a few hurdles out of the way, the final section discusses several key practices that are the basis for excellent ultradwarf bermudagrass putting greens. Superintendents who can refine these practices over time, in response to results on their golf courses, will be rewarded.

Frequent Watering

This may be a shock to many and heresy to others, but it doesn't take long to dry down in the top inch. Ultradwarf bermudagrasses are shallow-rooted, and most observed in the Southeast have root systems of two inches or less, with a predominance of roots in the upper inch. Also, the density of many ultradwarf stands is incredibly tight, and it is common to see water running off slopes and not into the soil. The best results in the field result from superintendents watering their ultradwarf putting greens every day or two during the growing season.

Frequent watering does not have to mean overwatering. Set up the irrigation cycles relative to the wettest portion of each green. Hand water slopes and chronically dry areas. Use wetting agents, too. Research at Clemson University and in the field has shown that wetting agent use does improve ultradwarf turf quality on sand-based rootzones (Martin and Camberato, 2002).

Mowing Practices

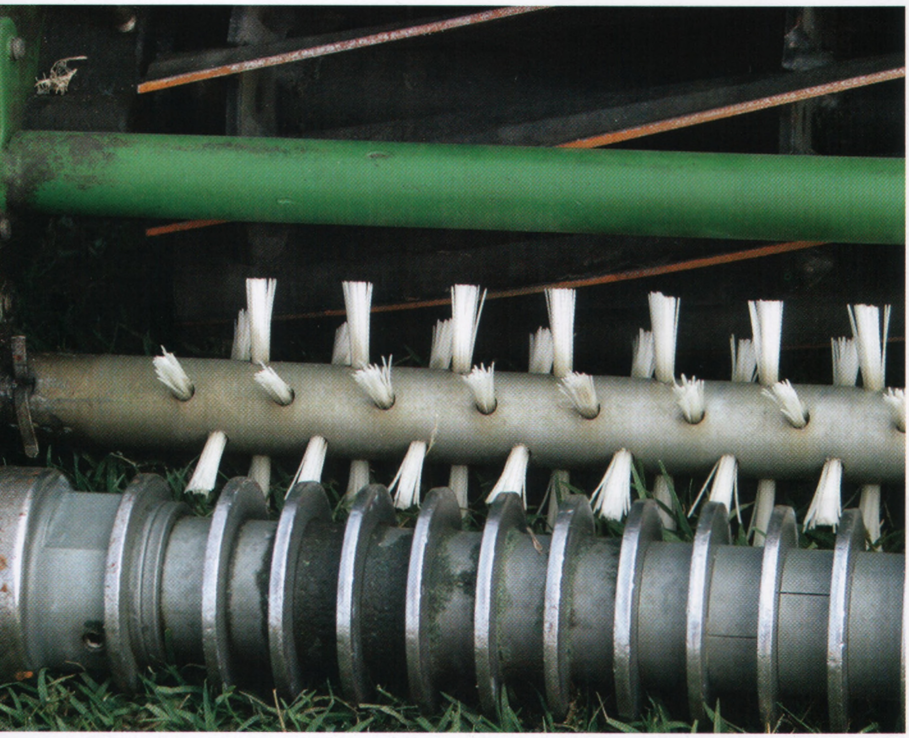
The quality and attention to detail of a mowing program has a profound impact on the quality and playability of an ultradwarf bermudagrass putting green. Once thought to be the domain of walking mowers only, there are numerous courses in the region that have achieved their standards with triplex mowers. Given the difficult economy, this number is certain to increase in the years ahead.

Hand watering remains an integral part of an ultradwarf management program.

Regardless of mower type, keep several considerations in mind. First, ultradwarf bermudagrasses do perform well at low heights of cut when the weather is cooperative (temperatures and adequate sunlight). Leaf texture and density appear to improve as the height of cut moves down. However, as height of cut moves down, the amount of work behind the scenes increases dramatically. A few factors to consider as mowing height is decreased are included below.

- More skill, precision, and time are necessary to set up the mowers, requiring the mechanic to allocate more of his time to mowing equipment. It may mean that the mechanic must delegate other tasks.
- Inconsistencies in a mower are magnified when it is used on a putting green.
- Sharpness becomes more important. More time will be spent on bedknife and reel sharpening and adjustment.
- At lower heights of cut, more sand will be picked up, necessitating the use of backup mowers after topdressing or requiring more time on reel and bedknife maintenance.
- Expenditures for parts will go up.

Rotary brushes on a walking mower are a good tool to promote upright growth and minimize the impact of grain.



An excellent summary of the considerations for long-term success can be found in an article by Tom Cowan called "Going Low with Ultradwarf Bermudagrass Putting Greens," which appeared in the November/December 2001 issue of the *Green Section Record.*

Surface Management

As noted earlier, aggressive vertical mowing or dethatching is not advised. When most superintendents think of the practice of vertical mowing, a corrective practice is brought to mind. Instead of waiting for a situation to occur that would warrant a corrective practice — in our case an excess of undiluted mat at the surface — success can be achieved by a preventative approach through frequent grooming. Grooming in this article refers to the depth of the blades, not the equipment used. Frequent grooming helps reduce the influence of grain and results in additional clipping removal by a follow-up mowing. The three-step regimen of 1) a morning mow, 2) light grooming with vertical mower blades on a triplex mower, and 3) a second mowing, has worked well in the field. Small, shallow channels may be noticeable, but they are not disruptive to play and not injurious to the turf because the depth is so shallow. The grooming practice helps stand up the grass between the small channels, and the second mowing is effective in removing even more clippings without an adjustment in mowing height. These channels also aid in future light topdressing incorporation. For a more complete discussion of this topic, refer to an article by John Foy of the USGA Green Section that appeared in the January/February 2008 issue of the *Green Section Record.*

Organic Matter Dilution

It has been said that the solution to pollution is dilution. The same can be said for organic matter management in the upper rootzone. Core aeration, surface sand topdressing, and judicious nitrogen applications are tools for managing the buildup of organic matter in the rootzone. Long-term success with any putting green in the region must include an appropriate core aeration and sand topdressing program.

A popular trend in the region, and one that is sound agronomically, is to complete all core aeration on one date in July or August, using a technique known as *close center aeration.* Either the putting green is aerated twice on two-inch centers, or an aerator with variable spacing is used to create a comparable number of holes per square foot. All disruptive aeration is performed on one date, which is far friendlier to the business of golf than multiple aeration dates. A more detailed discussion of this topic can be found in the article "Aeration and Topdressing for the 21st Century" that appeared in the May/June 2004 issue of the *Green Section Record.*

Use of Plant Growth Regulators and Wetting Agents

Trinexapac ethyl (Primo) continues to be the most popular plant growth regulator used on ultradwarf bermudagrass putting greens and is a staple on most of the best ultradwarf putting greens observed in the region. Primo is used to reduce the vertical growth rate and, in doing so, clippings are reduced and a higher quality of cut is achieved. Further dwarfing of the grasses occurs, with Primo producing an even tighter, denser surface. University research has documented some of these benefits, too (Bunnell and McCarty, 2004).

Wetting agent use is more sporadic throughout the region. The results of two studies are worth noting with respect to wetting agent use. Drs. Camberato and Martin at Clemson found that wetting agent use is appropriate for optimum turfgrass quality and localized dry spot avoidance. Dr. Keith Karnok (University of Georgia) offered two comments in a recent article that should get the attention of everyone who manages a sand-based rootzone. The first comment is, "Our research has shown that most sand-based rootzones 18 months or older will have some degree of soil water repellency." Also, "Research has shown that if water-repellent soil is found in one portion of a turfgrass area — in this case a green — almost without exception, soil water repellency will be present throughout the green even though localized dry spots may not be apparent." These are compelling arguments for the use of wetting agents.

Nitrogen Management

Managing the rate of growth appropriately has a major impact on playability. The most practical and successful approach observed in the field is to make an early season, slow-release nitrogen application to provide a small and predictable background level of growth. As the temperatures warm up, begin to spoon feed small amounts of nitrogen every 7 to 14 days to bring the growth rate of the grass in line with expectations. Start with smaller quantities, and if some scalping appears, back off. If vigor or growth response is not fast enough, gradually increase the spoon feeding amounts.

CONCLUSION

Managing ultradwarf bermudagrass in the transition zone requires a solid understanding of turfgrass management fundamentals, but it also requires the artistry of a craftsman. For superintendents who are switching from bentgrass putting greens to ultradwarf, less time will be spent on turf survival techniques and more time will be available for creating the best playing surface possible. Several stumbling blocks were presented in the first part of the article, and avoiding them is a great first step. The remainder of the article presented several key areas that will form the basis of the management program. Think of these areas as a path to success and a destination that will not be reached. Each season, it is likely that small modifications will be made based upon previous results. With diligence and an awareness of solid fundamentals, the new horizon will lead to a bright day for superintendents and golfers.

As an agronomist in the Southeast Region, CHRIS HARTWIGER *has the luxury of being able to hone his golf game on both bentgrass and ultradwarf bermudagrass putting greens.*

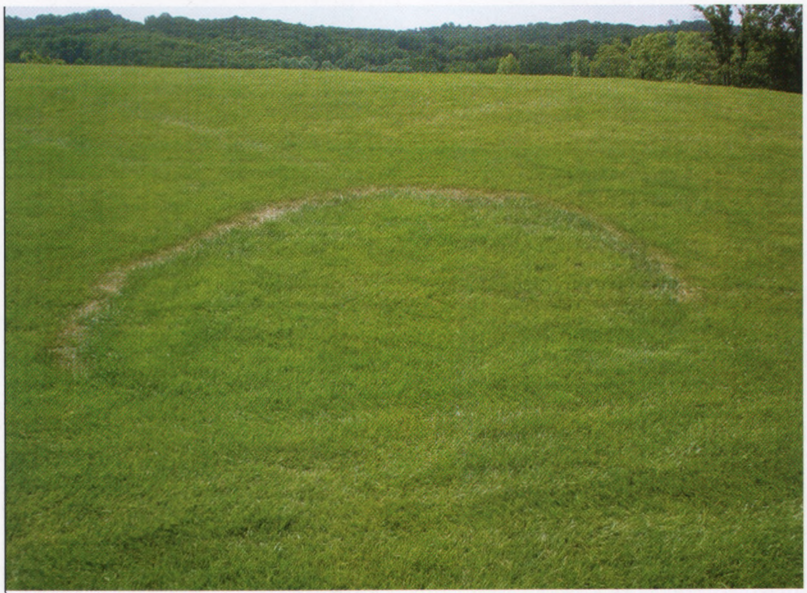
Winter wear tolerance of ultradwarf bermudagrasses is strong enough that overseeding can be avoided. The putting green in the foreground has been painted to add color. The green in the background is in the process of being painted.

Fairy Ring 101

The curious, elusive, but troublesome fairy ring.

BY MIKE FIDANZA, PH.D.

The "fairy ring" has long been a subject of folklore and legend dating back to pre-medieval times.[2,21] In fact, the largest single organism on earth is actually a fairy ring-type fungus *Armillaria* sp., which has been slowly growing and decomposing oak tree roots in a 37-acre site in northern Michigan for nearly 1,500 years, and this humongous fungus is estimated to weigh 21,000 pounds.[19] In turfgrass ecosystems, fairy ring symptoms are described as a circle or ring of mushrooms, lush green circular or semi-circular bands of grass, or rings or arcs of necrotic or dead turf.[5]



Type-I fairy ring symptoms are the most severe and are associated with necrotic or dead turf.

The fungi that cause fairy ring symptoms in turf belong to the basidiomycete or mushroom group, and these fungi grow and colonize the soil, rootzone, and thatch.[18] In nature, these fairy ring fungi are known as wood-decayers, which means they enjoy a diet of lignin. Lignin provides strength to plant cell walls, is common in all higher plants,[16] and is a major component of turfgrass thatch.[3] In fact, lignin is the second most abundant organic compound on Earth after cellulose, which is the major component of turfgrass leaf blades.[3,16] This may explain why fairy ring symptoms are often observed in turf near trees or in older native soil greens that contain buried tree stumps, other organic debris, and composts.

Fairy ring-causing fungi do not directly infect turfgrasses like other pathogens such as *Pythium* sp. or *Rhizoctonia* sp., but indirectly cause turf damage by disrupting the environment below the surface.[7] As the fungus decomposes organic matter, its mycelium and other substances coat the surfaces of sand and soil particles, contributing to the development of hydrophobicity or soil water repellency in the rootzone.[9,12,14,15,17] With type-I fairy ring, the loss of turf and stand density is due to the detrimental reduction in plant-available water in the soil, the inhibition of nitrogen and other nutrients, and the accumulation of ammonium to levels toxic to plant roots.[6,7,9,11] Elevated concentrations of ammonium and also sulfides in the soil rootzone correspond to a lack of bacterial activity needed to process those compounds due to the low soil moisture content and/or soil water repellency conditions.[9] It is an interaction of all these factors that causes the grass to suffer. So, a combined knowledge of plant and soil sciences, biology, and plant pathology are needed to understand the fairy ring complex in turf and on your golf course. This knowledge can improve your control of this soil-borne, thatch-borne problem.

A COMMON PROBLEM

In the past, fairy ring symptoms may have been dismissed as a curiosity with minimal impact on the turf surface or interference with the game of golf. Higher nitrogen fertility rates, the use of maintenance products that contained banned heavy metals (cadmium- and mercury-based fungicides, for example), higher mowing heights, and irrigation practices were very helpful with masking fairy ring symptoms in turf.[5,18] Today, a reduction in fertility practices, lower mowing heights, increased use of sand for topdressing and in new construction, and irrigation practices (i.e., longer wet/dry cycles) all contribute to the persistent appearance of fairy ring symptoms.[7,9] A major concern is the development of soil water repellency and localized dry spot conditions often associated with type-I and type-II fairy ring symptoms, and scalping on greens associated with stimulated turf from type-II symptoms.[4,6,7,9,13,14] Fairy ring symptoms are commonly observed on new courses, newly rebuilt or renovated areas, and turf areas within one year after establishment, but also on older and long-established areas.[5,7,18] Fairy ring symptoms in turf can be observed at any time of year, but they often occur during periods of hot/humid and dry weather, especially in turf that is under-fertilized.[7,18] Truly, the fairy ring family of organisms is incredibly diverse and occurs over a wide range of environmental conditions. This is why the problem is so common here in the U.S. and worldwide. The argument could be made that fairy rings are the most common problem affecting golf turf worldwide, since these organisms are growing everywhere turfgrass is grown.

WHAT TO DO?

The unpredictable nature of fairy ring and its destructive impact on turfgrass frustrate even the best golf course superintendents. Some fungicide products are now available to treat fairy ring symptoms. Table 1 details currently labeled and soon-to-be-labeled products for fairy ring management. This is a good reference list to keep handy. After all, with fairy rings being such a problem, it is not a question of whether fairy rings will become a problem, but rather what to do when you get them.

In the research work done at Penn State, successful performance of those products applied in a preventive or curative program may be improved with the combined use of a soil surfactant and a higher-than-usual water-carrier volume.[4,5,8,10,13] The extra water is important for coverage and to move the fungicide into the target area below the turf canopy.[9,10] Spot aeration also can help.[5,8] Lee Miller, graduate student at North Carolina State University (Raleigh, N.C.), under the guidance of Dr. Lane Tredway, currently is investigating fungicide application timing for symptom reduction in greens.[20]

An ideal fairy ring control program would start with aeration (i.e., needle-tine the affected area) to help vent excess ammonium, which can damage grass, but more importantly to promote oxygen into the rootzone. Next, an application of a soil surfactant followed by a fungicide (either sequentially or in a tank mix) in 100- to 150-gallon water-carrier per acre and then watered in, is essential for control. Do not under-water or over-water these treatments, since one or two turns of the irrigation heads or a light syringe is helpful, if not essential, to move the material off the turf canopy and into the zone where the fairy ring organism is growing.[5,8]

Be careful of those irrigation practices during stress times that over-wet or saturate the soil, as this can lead to wet wilt.[18] Equally, enough water needs to be applied to avoid a hydrophobic rootzone that is difficult to re-wet.[4,13,17]

Table 1

List of fungicide products currently labeled for treatment of fairy ring symptoms in the USA.

Active Ingredient	Trade Name and Formulation	Manufacturer[1]	Remarks[2]
Azoxystrobin	Heritage 50WG	Syngenta	0.4 oz., 28-day interval, 4 gal. water/1,000 sq. ft.
Azoxystrobin	Heritage TL	Syngenta	2 fl. oz., 28-day interval, 4 gal. water/1,000 sq. ft.
Azoxystrobin + Propiconazole	Headway 1.39EC	Syngenta	3 fl. oz., 28-day interval, 4 gal. water/1,000 sq. ft.
Fluoxastrobin	Disarm 480SC	Arysta	0.36 fl. oz., 28-day interval
Flutolanil	Prostar 70WP	Bayer	Preventive: 2.2 oz., 21-28-day interval Curative: 4.5 oz., 30-day interval
Metconazole	Tourney 50WDG	Valent	Label addition pending
Polyoxin-D	Endorse 2.5WP	Cleary	4 oz., 2-3 applications, 7-day interval, minimum 2 gal. water/1,000 sq. ft., include soil surfactant, irrigate 0.05 to 0.1 inch
Pyraclostrobin	Insignia 20WG	BASF	0.9 oz., 28-day interval
Tebuconazole	Lynx 2SC	Bayer	Label pending
Triadimefon	Bayleton 50WP	Bayer	1-2 oz., 14-day interval 2 oz., 21-day interval (*Poa* greens) (refer to label for preventive use instructions)

[1]Arysta LifeScience, Research Triangle Park, N.C.; BASF, Research Triangle Park, N.C.; Bayer Environmental Science, Research Triangle Park, N.C.; Cleary Chemical Company, Dayton, N.J.; Syngenta Professional Products, Greensboro, N.C.; Valent USA Corp., Richardson, Texas.

[2]Product rate/1,000 sq. ft., application interval, and water carrier volume/1,000 sq. ft. as listed on the product labels. Refer to product labels for specific information and instructions for product use. This list may not be inclusive of all commercially available products.

FAIRY RING RECURRENCE

The recurrence of fairy ring symptoms on the same green or fairway year after year may warrant a preventive or proactive approach. Experience from the field and research from North Carolina State University suggests that spring applications of triadimefon (Bayleton 50WP) and tebuconazole (Lynx 2SC) can be helpful in preventing the onset of fairy ring symptoms.[20] "The DMI fungicides triadimefon and tebuconazole provide excellent preventative control of puff-ball fungi *Lycoperdon perlatum* and *Vascellum pretense* in golf course putting greens. Two applications

Type-II fairy ring symptoms are described as stimulated plant growth as evidenced by circular bands of dark green actively growing turfgrass.

on a 30-day interval, beginning in spring when five-day average soil temperatures reach 55°F, have provided season-long control in many cases."[20] The same results can be expected on tees and fairways. However, be mindful of possible interactions between DMI fungicides and plant growth regulators. For curative control, again, refer to Table 1.

Questions are always asked about the use of soil modification or soil amendments and fairy ring. Realistically, most golf courses have been on soil modification programs using core aeration and topdressing with sand. Has this made the fairy ring probem worse or better? It is hard to say. Equally, the same could be said for soil amendments. Results from the field have been variable where superintendents have spot-treated or injected with inorganic soil amendments. Is the fairy ring being suppressed, or are the symptoms being masked? Again, it is hard to say. Research is ongoing to answer these questions about the way soil modifying products may or may not affect fairy ring. Interestingly, in rare occurrences, some superintendents have dug out and physically removed the fairy ring-affected area. This is a disruptive, time-consuming, and messy chore, and it's questionable whether it provides a long-term cure. It is hard to say. It does underscore just how frustrating this problem can become. Using chemical controls may ultimately prove to be a better option than a sod cutter or a shovel. In addition to fungicides and soil surfactant strategies, a soil nutrition approach to fairy ring control is now offered by 3Tier Technologies (Southlake, Texas), and similar kinds of products from Grigg Brothers (Albion, Idaho) and others are currently being tested. More information on those approaches to fairy ring control will become available soon.

THE BOTTOM LINE

Sometimes these various treatment programs work, and sometimes they do not. What works to successfully manage fairy ring on one golf course may not work on another golf course, or even at a different location on the same golf course. After all, there are potentially more than 60 species of fungi that have been associated with fairy ring symptoms in turfgrass,[5] and these species likely vary in their sensitivity to fungicides.[8,10,20] Although new research results will provide a glimpse into the elusive world of the fairy ring, there is still much to explore and understand about fairy ring in turf. Today's turf manager does, however, have more good options to manage this problem than existed a few years ago.

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Exploring Biocontrol of Annual Bluegrass Weevil

Rutgers University scientists investigate if insect-parasitic nematodes can provide biological control of this serious insect pest.

BY BENJAMIN A. McGRAW AND ALBRECHT M. KOPPENHÖFER

Above: The annual bluegrass weevil, *Listronotus maculicollis* (formerly called Hyperodes), principally feeds as larvae on annual bluegrass. Adults mostly overwinter in protected areas along the edge of woods or in the rough.

Left: With two to three generations per year, this weevil can build to astonishing populations (small patches may reach 1,200 larvae per square foot) that can stress or kill annual bluegrass in greens and fairways.

OBJECTIVES

- Conduct surveys for entomopathogenic nematodes in annual bluegrass weevil (ABW) infested areas and adult annual bluegrass weevil hibernation sites on golf courses.
- Determine the virulence to annual bluegrass weevil of entomopathogenic nematodes in laboratory bioassays.
- Determine the field efficacy of promising entomopathogenic nematodes.

Start Date: 2006

Project Duration: Three years

Total Funding: $69,532

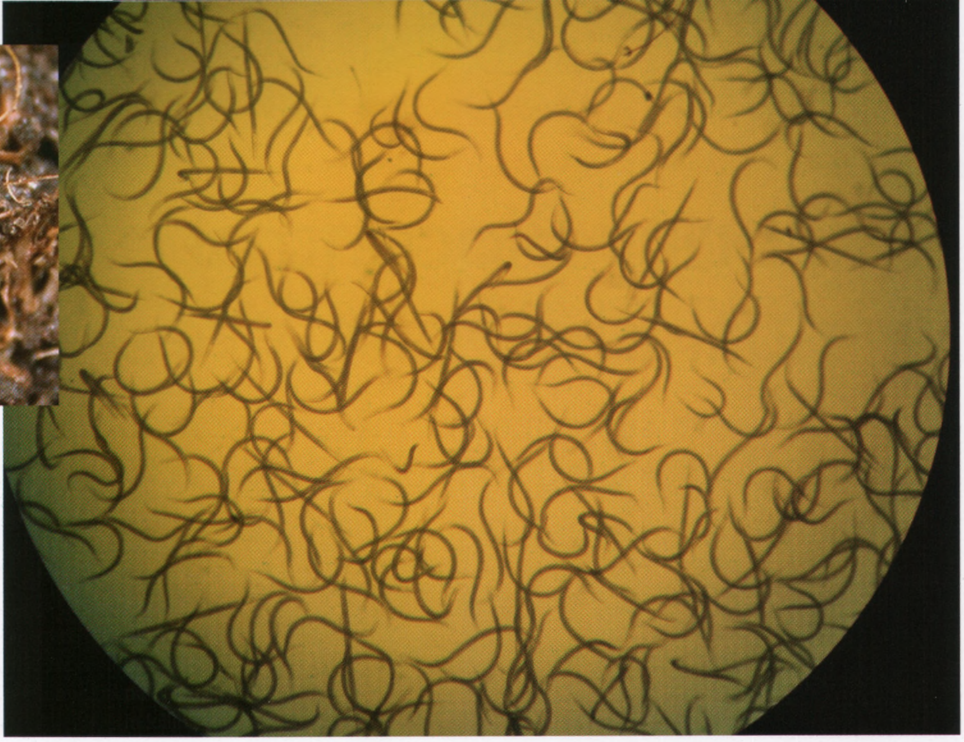
The annual bluegrass weevil, *Listronotus maculicollis*, formerly "Hyperodes weevil," is a serious and expanding pest of close-cut annual bluegrass on golf courses through much of the Northeast. At the latitude of New Jersey, adult annual bluegrass weevils emerge from overwintering sites in leaf litter and tall rough in early April and migrate to short mowed turfgrasses (greens, tees, fairways) to feed and mate. Females lay eggs directly into the stem of the turfgrass plant from late April through May.

The young larvae are initially stem borers, feeding internally on the plant, ultimately tunneling through the crown and destroying the turfgrass plant. Later instars feed externally on crowns and roots, which leads to the most extensive turf loss, typically around early to mid-June. Damage caused by the second and third generations is usually less severe and more localized as peak larval densities tend to be lower than in the first generation.

Two species of entomopathogenic nematodes (EPNs), *Steinernema carpocapsae* and *Heterorhabditis bacteriophora*, were found regularly infecting annual bluegrass weevils in golf course fairways not treated with insecticides for weevil control. Endemic EPN populations were capable of reducing a single weevil generation by up to 50%. However, the density of EPNs and

Above: Over the past few years, the annual bluegrass weevil has become one of the most difficult insect pests to manage on golf courses.

Right: Entomopathogenic nematodes are microscopic roundworms found in the soils of most ecosystems. They attack insects by entering through natural openings or in some instances directly through the insect's cuticle. Once inside the insect's body cavity, entomopathogenic nematodes release symbiotic bacteria that assist in killing the insect, usually within 48 hours.



their impact on weevil populations were negatively affected by extreme environmental conditions (e.g., low soil moisture, high temperatures). Therefore, EPN populations will need to be augmented to provide more consistent control of annual bluegrass weevil populations on golf courses.

The virulence of commercial and endemic strains of EPNs to annual bluegrass weevil larvae and adults was examined in the laboratory. Moderate levels of adult control (50-60%), even under optimal laboratory conditions, suggest that the adult stage is a poor target for EPN. Conversely, fourth and fifth instar larvae were highly susceptible to nematode infection (65-100%) in field-infested turf cores in the laboratory. *Steinernema feltiae* and *S. carpocapsae* provided the greatest level of control to both stages of the insect (>90%). Because control decreased between fourth and fifth instar stages, timing of applications in the field is likely to affect the level of control.

Multiple field trials have been conducted with endemic strains and commercial EPN products against first generation annual bluegrass weevil immature stages between 2005 and 2008. No significant differences in efficacy or persistence were detected between commercial and endemic EPNs. Standard rates (1 billion infective juveniles per acre) of *S. feltiae* and *S. carpocapsae* provided over 85% control against low to moderate weevil densities (20-40 per square foot). In the 2007 but not in the 2008 trials, treatments consisting of combinations of species and applications split into half doses applied in consecutive weeks provided higher levels of control than the 1 billion infective juveniles per acre rate alone. Overall, control levels were inconsistent, with the most consistent result observed with *S. carpocapsae*. Nevertheless, there is evidence for potential high levels of control with several species of EPNs when applications are timed appropriately. Products based on *Steinernema feltiae*, *S. carpocapsae*, and *Heterorhabditis bacteriophora* have been chosen for closer examination since they have provided at least 70% control in past field trials.

The inconsistent control levels are likely due to numerous abiotic (e.g., weather, soil type) and biotic (e.g., EPN formulation, nematode persistence, annual bluegrass weevil density) factors. Another year of field trials will be conducted to solve some of the inconsistencies in control of annual bluegrass weevils with EPNs.

SUMMARY POINTS

- Entomopathogenic nematodes can provide significant control of annual bluegrass weevil larvae. However, in field trials, control has been inconsistent between years.
- The level of suppression achieved in the field is likely affected by factors such as nematode concentration, annual bluegrass weevil larval densities, and timing of application.
- An additional field season should help clarify the effects of application timing and concentration and annual bluegrass weevil density on the ability of nematodes to suppress annual bluegrass weevils below damaging thresholds.

RELATED INFORMATION

http://usgatero.msu.edu/v07/n15.pdf
http://usgatero.msu.edu/v05/n19.pdf
http://turf.lib.msu.edu/ressum/2007/5.pdf
http://turf.lib.msu.edu/ressum/2006/9.pdf
http://turf.lib.msu.edu/ressum/2006/8.pdf
http://turf.lib.msu.edu/ressum/2005/10.pdf
http://turf.lib.msu.edu/ressum/2004/11.pdf

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CONNECTING THE DOTS

An interview with Drs. Albrecht Koppenhöfer *and* Benjamin McGraw *regarding their work with biological control of annual bluegrass weevils.*

Q: *How does your work with ABW integrate into the overall strategy of the Northeast Regional Hatch Project 1025, which is investigating anthracnose and annual bluegrass weevil damage of annual bluegrass? Are you participating with other northeastern universities in any cooperative projects?*

A: A major objective of the regional project is to find alternatives to synthetic pesticides, and nematodes are alternatives that could be applied on a curative base. Another objective is to reduce pesticide use in general. We are also working on developing better tools to predict if and where ABW larval densities may warrant control. If we can optimize both nematode efficacy and prediction tools, it would be possible to not only drastically reduce the need for applications, but also use a biological control agent for the remaining treatments. This could increase the impact of naturally occurring ABW natural enemies, which in turn might decrease the need for applications. And, yes, we have been cooperating with Drs. Vittum (U.Mass.) and Cowles (U.Conn.) on some aspects of the nematode work and developing better ABW sampling techniques.

Q: *Some researchers have reported that ABW can also feed on bentgrass. Have you ever seen this in your work with ABW?*

A: We have not conducted specific feeding studies, but we certainly find the rather immobile ABW larvae in patches of pure creeping bentgrass. Our work on ABW ecology and monitoring suggests that mowing height may be a more important factor than grass species in determining where the females lay eggs. But we also found that creeping bentgrass can tolerate several times higher ABW larval densities than annual bluegrass. Therefore, damage appears much earlier in annual bluegrass, which could be erroneously interpreted as host preference.

Q: *For years, the standard method for controlling ABW was a pyrethroid insecticide application in early spring, as the adults are migrating from their overwintering sites. Isn't this still the main control strategy, and is it still effective in controlling ABW?*

A: Preventive broadcast sprays of pyrethroids are still the main control strategy and probably still work in most cases. There is, however, increasing evidence for pyrethroid resistance in ABW populations, and continued overuse of this chemical class will only exacerbate the problem. There are some very effective newer insecticides from different classes (Acelepryn, and anthranilic diamide; Provaunt, an oxadiazine; Conserve, a spinosyn), but there is also some limited evidence that pyrethroid-resistant ABW are less susceptible to some of these products. Rotation of insecticide classes is a good tool for resistance management, but reducing insecticide use to what is really necessary in time and space is just as important.

Q: *It would seem that the use of entomopathogenic nematodes (EPNs) to control ABW would need to be very target oriented. To what extent does this control strategy require timely scouting and accurate record keeping by superintendents?*

A: Because of their relatively short residual, nematodes have to be applied in a curative mode, ideally when the majority of ABW larvae are in the third and fourth stage. Earlier, too many larvae would still be protected from nematode attack inside the plants, and later would increase the risk of grass damage. This seems to coincide quite closely with full to late bloom of the popular hybrid rhododendron *Rhododendron catawbiense*. Superintendents should keep records of where they have had ABW problems. Then they could start scouting for ABW larvae in at-risk areas just before full bloom of the hybrid rhododendron and apply nematodes (or other curatives) when they start seeing significant numbers of larvae in the soil.

Q: *How long is the migration period of ABW adults from overwintering sites, and does an extended migration period cause problems in trying to contol this pest? Are there degree-day models for ABW to help predict the optimum application period for insecticides, as there are for other turfgrass pests?*

A: We typically detect the first adults emerging on fairways around early April in northern New Jersey. Our studies, along with other independent studies throughout the Northeast, have detected a bi-modal emergence of adults. Our first peak occurs around the third week of April and the second peak in the first week of May, suggesting at least three weeks of significant emergence. However, the duration of emergence or adult movement is likely to be affected by temperature, and it is possibly confused by the distance between overwintering sites and short-mown playing surfaces. Control may be less than optimal if action is taken against the first wave of adults, especially if the product used has a short residual.

Degree-day models for ABW have been examined in at least three separate studies, with each study using slightly different methodologies and arriving at different degree accumulations for predicting development. In our studies in New Jersey, calendar date rather than degree-day accumulation seemed to be the better predictor for ABW development. Incorporating other variables in addition to temperature could increase the accuracy of degree-day models for population development. Nonetheless, superintendents should scout or monitor population development, so that population density and development are weighed before action is taken, rather than applying solely based on calendar date.

Q: *Albrecht, you've done some excellent work with EPNs to control white grubs (e.g., larvae of scarab beetles). How much does the research with EPNs and ABW parallel the white grub work, and how has it differed substantially?*

A: With ABW, hardly any work has been done before, and we had to essentially start from scratch. Accordingly, for the virulence/efficacy studies, we have primarily used commercial nematode products, no different from what a superintendent would be using. White grubs, on the other hand, are among the best studied targets for EPN. Accordingly, my white grub studies were more in-depth, isolating and developing new and better EPN species and developing more effective ways of using them.

Q: *If superintendents are to rely solely on EPNs to control ABW larvae (and perhaps white grubs), is it reasonable to expect "boom and bust" cycles so typical of predator-prey populations in nature?*

A: This could well happen if they would rely solely on natural EPN populations, and our studies of interactions between natural EPN and ABW populations suggest that natural EPN cannot be relied upon to prevent turf damage by ABW. But "boom and bust" is irrelevant for inundative applications of EPNs for curative ABW control.

Q: *Currently, how many species of EPNs are commercially available, and how well do EPNs fit into an IPM approach that may involve chemical pesticide use?*

A: There are at least seven species available in the USA and a few additional ones in other countries. EPNs fit very well into IPM in general, as they have no negative effects on other insect natural enemies. There are some chemicals that need to be applied several weeks earlier or later than the nematodes (obviously nematicides), but most can be applied at the same time, and some are even tank-mix compatible. Several chemicals have been shown to interact synergistically with EPN on the mortality of some insect pests, in particular imidacloprid (Merit) and chlorantraniliprole (Acelepryn) with EPNs for curative white grub control.

Jeff Nus, Ph.D., *manager, Green Section Research.*

Will the Real Alternative to Methyl Bromide Please Stand Up?

Fumigation facts you should know if your golf facility is considering putting green renovation.

BY TY McCLELLAN

PHOTOS COURTESY OF KEVIN BASHAM

Without methyl bromide, currently the only hot gas fumigation option, simple gas-and-regrass renovations will be gone, too. "Gas and regrass" refers to establishing putting greens with a new stand of turfgrass without reconstruction or even significant soil cultivation.

For some time now it has been known that the industry standard for soil fumigation of golf course putting greens would become unavailable. Methyl bromide was the preferred choice because of its broad-spectrum control of weeds, insects, nematodes, and diseases, but it will likely be phased out under the Clean Air Act and the Montreal Protocol because it was identified as an ozone-depleting substance. A potential ban on its use by the U.S. Environmental Protection Agency (EPA) now appears to be fast approaching, and we have yet to find a suitable alternative . . . or have we?

Considerable research has been performed over the last decade or so to evaluate many different fumigation products and methods, albeit very little within the golf and turf industries. These studies have included products that are currently labeled for use on turfgrass and those that are not, products in combination to achieve the desired levels of efficacy, and non-chemical methods, such as solar and steam disinfestation.

This article is written in regard to the use of methyl bromide for renovating putting greens and not for golf course fairways or sod farms. It is not intended to dispute or advocate the availability of methyl bromide, nor is it intended to validate the importance of effective fumigation for successful, long-term putting green renovation. Rather, it is hoped that information in this article will serve as a guide to golf courses currently or soon to be considering putting green renovation. For some, this article may spur a push forward to complete renovation plans sooner so that they can still use methyl bromide while it is available, whereas for others, it will help identify factors to consider when selecting an alternative soil fumigation option in the future.

A summary of possible alternatives to methyl bromide, along with pertinent details regarding each, is provided below. The options are listed in no particular order.

The key to successfully establish a new, pure stand of turfgrass on greens is minimizing pest pressure and competition from existing vegetation, weeds, nematodes, insects, and disease pathogens at the time of planting.

Dazomet (trade name: Basamid) is a dry, granular soil fumigant with fungicidal, herbicidal, and nematicidal properties. It must be incorporated into the soil or applied to the soil surface and watered in to be activated. Tarping is optional and would require a means of getting water under the tarp. Dazomet has been used to renovate turfgrass areas in the past, including golf course fairways and greens. Studies in 2000, 2001, and 2002 showed it to be a good candidate as a methyl bromide alternative, given its ability to suppress *Poa annua* during the grow-in of bentgrass greens (Landschoot and Park, 2004). It is not nearly as effective on warm-season turf (i.e., bermudagrass). Although the cost of dazomet is similar to the cost of methyl bromide, it produces less consistent results across a variety of soil and environmental conditions. Additionally, the product moves during heavy rainfall and is toxic to surrounding turf and aquatic life. Given that its residual is moderate in the soil, the label recommends waiting a minimum of 10 days before planting, depending on soil temperature.

Methyl iodide (trade name: Midas) is the first new soil fumigant to be registered by the EPA in more than two decades. Research done in other industries has shown it to be as effective or more effective than methyl bromide in controlling weeds, soil-borne fungi, and nematodes when applied at rates comparable to methyl bromide. A waiting period of 10 to 14 days is required after application before planting can begin. The recommended rates for turf sites are approximately half that of methyl bromide, but methyl iodide costs considerably more than methyl bromide to be as effective, so methyl iodide may not be economical for some uses.

Dimethyl disulfide or **DMDS** (trade name: Paladin) appears to be a suitable alternative to methyl bromide, given research conducted outside the turf industry. It is of similar effectiveness and cost and has been shown to be comparable to methyl bromide in its broad-spectrum control of nematodes, disease pathogens, and weeds. Although little information is available on DMDS, research on turf is currently being conducted at the University of Florida (Unruh, personal communication). Reportedly, a longer waiting period is necessary prior to planting when compared to methyl bromide. Additionally, a horrendous sulfur smell is reported to linger for up to several days, which could be problematic for courses within residential areas. The labeling for DMDS will likely be targeted for areas of vegetable production and other food crops, with potential availability in turf markets sometime in 2009 or 2010.

Chloropicrin (tear gas) is registered as a broad-spectrum soil fumigant that exhibits excellent control of fungi, but does very little to control weeds. For this reason, it is commonly used in conjunction with methyl bromide or 1,3-D. This product is either injected into the soil or applied via drip irrigation. These applications can either be tarped or not tarped, and planting can begin approximately seven days after application.

Dichloropropene or **1,3-D** (trade name: Telone II) is a liquid, pre-plant soil fumigant registered for use on commercial turf farms to control nematodes and mole crickets. When used at rates that target nematodes (9 to 18 gallons per acre), there is limited impact on some soil-borne insects and no impact on weeds or pathogens. Only rates greater than or equal to 35 gallons per acre will effectively control weeds. This is why it must be combined with other fumigants, such as chloropicrin, to achieve broad-spectrum control. 1,3-D is applied using tractor-drawn rigs that inject it 12 to 18 inches beneath the soil surface. The soil surface must be sealed after application by compacting the top layer of soil, applying a water seal, or covering with tarps. The label suggests an application rate of 9 to 18 gallons per acre and a waiting period of one week for every 10 gallons applied per acre before planting.

Metam sodium (trade name: Vapam, Sectagon) is a broad-spectrum soil fumigant registered for use on turf. As with dazomet, water is required to activate it, and thus its efficacy and expectations for consistent results are oftentimes jeopardized when soil moisture and temperature are not ideal. Given its sporadic control and the waiting period of 14 to 21 days before planting, it is not ideal for putting green renovations.

Combining the products listed above to achieve improved, broad-spectrum fumigation control is another option that makes sense for fumigants that are not effective against all pests. Unruh and Brecke (2001) found several combinations that offered moderate to good control of most turfgrass pests, such as chloropicrin/1,3-D, chloropicrin/dazomet, chloropicrin/metam sodium, and 1,3-D/metam sodium. To ensure that there are no toxic effects for the germinating turfgrass seedlings or sprigs, it is best to defer to the product with the longest waiting period.

Soil solarization involves covering soils with clear plastic so that the heat derived from solar energy disinfests the soil over time. This process requires six to eight weeks to kill most nematodes and fungi. Due to an absence of research, its efficacy on weeds is unknown and, therefore, its value to turfgrass sites is also unknown. Given the time required for this option, it is impractical for most golf course uses, although sod farms may be potential candidates (Unruh, 1998).

Steam or **hot water** technology has been researched in some detail for nematode control, but given the amount of water and other inputs (i.e., diesel fuel) necessary, this option has not been shown to be economical, practical, or environmentally sound. Furthermore, it offers limited disease and weed control (Unruh, 1998). Dr. Unruh at the University of Florida is currently assessing its potential for use on putting greens, as advances continue within this technology.

Other alternatives include **soil amendments**, such as compost (the large quantities necessary make this impractical and economically unrealistic), **experimental products** not yet registered as soil fumigants, and, for an alternative to fumigation in general, registered **pre- and post-emergent herbicides** (Unruh, 1998).

Looking forward, it is anticipated that most, if not all, soil fumigants available for turf application will come with varying degrees of restrictions (if they even continue to be available for use on turf) following re-registration with the EPA. One such restriction is likely to be buffer zones extending anywhere from a minimum of 300 feet and up to a quarter-mile beyond treated areas. This could mean that fumigation for putting greens located in residential neighborhoods and urban communities where people are in close proximity to the course may require evacuating the premises for some period of time and/or closing local businesses and schools. This could prove to be more than a challenging proposition, to say the least. With these possibilities looming, research is currently underway to minimize gas permeability through plastic covers and tarpaulins used to seal fumigated areas. Product effectiveness should improve so that reduced application rates can be used, possibly shrinking buffer zones.

Since applying methyl bromide to turf does not fall under food production, its continued use is unlikely, and it may be dropped from the label soon. Even if it remains, buffer zones as previously described will likely be required, in addition to other safety restrictions. As it currently stands, methyl bromide can be purchased in advance for use at a later date, but this, too, is restricted. More specifically, methyl bromide will likely be re-registered with a new label in early 2010. If it is purchased with its current label, say anytime in 2009, it might still be used for up to 18 months after the new label is issued. With a new methyl bromide label in February 2010, for instance, those who purchased it in advance can use it anytime during the next 18 months or through August 2011. The legalities for physical storage of methyl bromide between when it is purchased and when it would be applied have not yet been determined.

As one can see, there are a number of fumigation options available. Unfortunately, as discovered during extensive research by Unruh and Brecke (2001), along with numerous researchers in a wide range of agricultural sectors, none of the current alternatives appear to meet all of the criteria once met by methyl bromide: that is, economical, consistently effective, and easy to use. While some products appear to be just as or more effective than methyl bromide in killing weeds, disease pathogens, or nematodes, they are either not economical or practical and, in some cases, not labeled for turfgrass use. Others, while easy to use or economical, do not measure up in terms of efficacy. Some require specific soil and environmental conditions, whereas others are not suited for residential areas or require too much time before seeding is allowed. Perhaps most discouraging is that methyl bromide, when applied as a hot gas, is the only soil fumigant that does not require extensive rototilling or soil cultivation. This means that the simplest and easiest method of reestablishing greens to newer stands of turfgrass would also be lost, as none of the other fumigants, including methyl iodide, can be applied in the same manner.

Life without methyl bromide will make successful putting green renovation more challenging. Science has always served as the foundation for improvements in product chemistries and techniques and, once again, we must rely on research and innovation to show

Course officials and staff at the Country Club of Peoria in Illinois inspect the results of successful fumigation using methyl bromide on a putting green.

Table 1
Available and Potentially Available Soil Fumigant Options

	Chemical							Non-Chemical		Chemical Combinations			
Product	Methyl bromide	Dazomet	Methyl iodide	Dimethyl disulfide (DMDS)	Chloropicrin (tear gas)	Dichloro-propene (1,3-D)	Metam sodium	Soil solarization	Steam (hot water)	Chloropicrin & 1,3-D	Chloropicrin & Dazomet	Chloropicrin & Metam sodium	1,3-D & Metam sodium
Trade Name		Basamid	Midas	Paladin		Telone II	Vapam, Sectagon						
Registered for use on turf?	•	•	•	Possibly in 2009 or 2010	•	Commercial turf farms only	•	•	•	Commercial turf farms only	•	•	Commercial turf farms only
Undergoing reregistration with the EPA[1]	•	•			•		•			•	•	•	•
Typical waiting time before planting	5 Days	10-17 Days	10-14 Days	Unknown	7 Days	7-14 Days	14-21 Days	42-56 Days	Unknown	7-14 Days	10-17 Days	14-21 Days	14-21 Days
Pests Controlled[2]													
Weeds[3]	•	•	•	•			•			•	•	•	•
Nematodes	•	•	•	•		•	•	•	•	•	•	•	•
Insects	•	•	•	•		•	•	•		•	•	•	•
Disease pathogens	•	•	•	•	•		•	•		•	•	•	•

[1] Reregistration Eligibility Decisions (REDs) for soil fumigants can be found at http://epa.gov/oppsrrd1/reregistration/soil_fumigants/.

[2] Simply indicates whether or not pests are controlled, but does not specify the level of control achieved. For instance, methyl bromide achieves good to excellent control for the target pests listed, whereas other fumigants may provide only poor to moderate control for the same pests.

[3] Weeds include broadleaf species, sedges (*Cyperus* spp.), and grassy weeds, such as annual bluegrass (*Poa annua*) and common and off-type bermudagrasses (*Cynodon* spp.).

A quick reference guide that compares available and potentially available soil fumigant options. This information was compiled primarily from registered product labels, the EPA website and fact sheets, and research by J. B. Unruh and B. J. Brecke of the University of Florida.

us the way. Fortunately, newer products and chemistries are becoming available. Today, we have the selective herbicide Velocity, which can be used approximately four weeks after bentgrass germination to control *Poa annua* invasion during fairway renovations. This is one example of how a newer product helps take the pressure off when attempting to control *Poa annua* contamination at the time of seeding, thereby reducing our dependency on soil fumigation in cool-season climates. In this particular instance, Velocity is not labeled for use on putting greens, but perhaps an option will soon be available.

If you are currently considering a putting green renovation at your facility, it may well be worth doing so sooner rather than later. And, while no project should ever be rushed, moving up the date to ensure that methyl bromide can be used may be worthwhile. The long-term success of your greens may even depend on it.

ACKNOWLEDGEMENTS

Thank you to J. Bryan Unruh, Ph.D., associate professor and extension turfgrass specialist at the University of Florida, and Kevin Basham of Hendrix and Dail Inc. for their assistance with this article.

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Unruh, J. B. 1998. Methyl bromide ban is coming soon. *Golf Course Management*. 66(11):67-70.

TY MCCLELLAN *is an agronomist in the Green Section's Mid-Continent Region. He has been fielding an increasing number of questions regarding fumigation at golf facilities currently considering putting green renovation.*

Plan Your Work, Work Your Plan

Know what it costs.

BY DARRIN M. BATISKY

Golf course superintendents face many challenges, and an uncertain economic climate intensifies the importance of staying current with evolving technology, balancing/managing the cost of course presentation, and first and foremost, meeting the needs and expectations of golfers. Golf course maintenance budgets are being scrutinized more and more each day. The rising prices of supplies, such as pest control products, fertilizers, fuel, parts, topdressing, etc., are making it difficult to maintain the status quo. Without question, these items are important and they significantly impact the budgeting process, but it is the labor-related expense, or human capital, that is the most significant component of the golf course maintenance budget.

Surveys have documented that a typical line item cost for labor to maintain a golf course is 50% to 60% of the total operation's budget. Unfortunately, the relative size of this line item, compared to the remainder of the budget, makes it an easy target for reduction by the governing body of the golf course. Being able to quantify labor needs, as based on the members' desired setup of the course, is critical and, in fact, essential to outlining the real cost of maintenance. Labor cost can be reduced, but not without affecting course setup criteria.

The cost of conditioning and presenting the turf in the desired manner needs to be quantified. Doing so provides a mechanism to equate budget numbers for course conditioning to efforts that are, after all, developed from analyzing golfer demands. Sounds simple, right? Most superintendents can approximate this information for each job on their courses, but I believe that a more formalized and accurate approach should be utilized to track work hours and the cost of operations.

DATA = KNOWLEDGE = POWER

As a student at The Ohio State University, I was exposed to a life equation by my advisor and mentor, Dr. Karl Danneberger: **Data = Knowledge = Power**. There are many applications for this equation. In turf management, we use university or independent research data as a starting point to determine which pesticide or fertilizer to use when formulating best management practices. Reviewing National Turfgrass Evaluation Program results (NTEP) provides information to make selections of grasses that will perform best in our area. Having access to *accurate and reliable* data is critical to make daily decisions, as well as guide

We track as many different mowing tasks as possible. By doing so we are able to quantify every effort, which then can be translated into a dollar cost.

the development of future programs. The old adage applies: "You can't manage what you don't measure," and measuring labor efforts is an important aspect of your budget process.

I was first exposed to this type of data collection as an assistant in northern New Jersey at Ridgewood Country Club, working under the direction of Ed Walsh, CGCS. One of Ed's standard operational procedures was to track labor use on the golf course. It was worth the effort and has become a standard operating procedure at our facility. Computer technology allows data collection, tabulation, and interpretation to be completed very efficiently. We make use of word processing to produce the forms and a spreadsheet application to enter and interpret data.

THE SYSTEM

Fast forward to my current superintendent's position at Chartiers Country Club in Pittsburgh, Pa. We use a form on which each employee enters hours worked for each assigned task. The forms are stored in an organizer that hangs on the wall in our break room, and there is a file folder for each employee. The accuracy of documenting labor activity is important because it provides a very clear picture of where member dollars are being invested in the care of their course.

Our form has 24 categories, but we focus heavily on tracking mowing costs. Mowing is divided into nine specific subcategories, each relating to a specific area of the property. The other 23 categories are common tasks performed on a regular basis. There is a miscellaneous category that is used to record activity for tasks that are not as defined, more dynamic, and subject to change.

Each crew member is responsible for adding up his or her work hours — horizontally for specific tasks and vertically for daily hours. The week's total labor for each employee is presented at the bottom right of the form. Summarized information from each sheet is then entered into an Excel spreadsheet by one of our assistants. The raw data are summarized, offering a running total of the labor cost of each activity conducted on our course.

These daily/weekly work records also serve as backup to our computerized time card system. Any issues that employees have with their paychecks can usually be resolved by comparing the labor sheets that they fill out with their paychecks. Occasionally mistakes happen, but this check and balance gives the employee and manager a means to correct the situation equitably.


All employee forms are contained in an organizer mounted on the wall near the time clock in the lunch room.

The spreadsheet looks similar to the daily work record; rows represent weekly task totals, and columns indicate weekly total hours worked. The data allow us to track labor costs during different times of the year, and we can track trends over time. For example, a few years ago we added naturalized areas to the golf course. While it wasn't specifically done to save money, the hope was that we could shift resources to more important areas of the property. We tracked the labor requirements of the naturalized areas in our miscellaneous designation. We wanted to know if there was any net gain/loss to our labor expenditures. What we found was that we were spending as much on labor to mow naturalized areas as we were spending on mowing our practice tee.

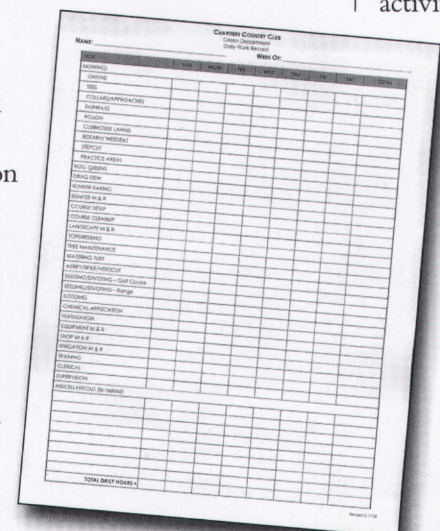
BUILDING THE HISTORY

We began tracking labor/time costs in the spring of 2002. At first, the data were utilized to explain where the cost of labor was being used. When we were asked about why we needed a specific level of labor to condition the course, we didn't have the support documentation to justify expenditure requests. Prior to tracking labor/time costs, requests for an increase in labor resources were structured according to what we thought was needed, versus knowing what it took (cost) to give our members what they expected. The program has evolved into a tool we use to quantify the labor costs of every aspect of course care. We know the labor cost of mowing the fairways and the labor cost of presenting the bunkers. We can summarize the cost of managing the tees as well as the naturalized areas. Tracking labor expenditures from year to year provides a mechanism to explain cost increases when members request a course setup change. Monitoring the trends can help explain how golfer demands affect labor costs.

The information also allows us to plan for the future. If we expand or alter a fairway, add or eliminate bunkering, create a collection area or increase our naturalized accents, we can budget more efficiently and accurately to manage these areas. Conversely, if we are asked to cut back, we can predict the effect on course conditioning if course setup is not changed. While we remain dedicated to meeting golfer demands, it is unrealistic to expect the same product can be presented with fewer resources.

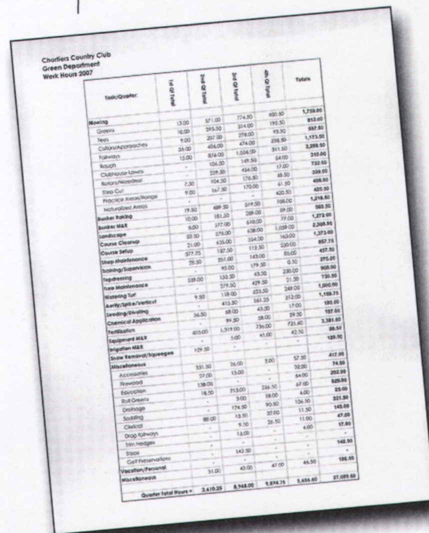
USING THE DATA: WHERE IS THE MONEY GOING?

I can tell you where we spend our labor maintenance dollars each and every day. Quantifying labor cost for each task places a tangible value on a member expectation of course presentation. By tracking and knowing what each regular task costs, we are also able to deal with the add-on items we are constantly asked to do or unexpectedly need to absorb. There have been several instances when we have needed to remove ice/snow during a midwinter thaw. Although we do not anticipate doing this every winter, tracking these man-hours helps explain where labor monies have been utilized and where shortages may occur in the future. On another occasion, we were asked to install intercept drainage around our golf shop in order to reduce the chance of flooding. We were able to perform the work with in-house labor, rather than using an outside contractor. While many recognized this was a saving, itemizing and tracking the labor cost helped explain the impact of this completed add-on project, which was absorbed in the golf course maintenance budget.


Chartiers Country Club
Green Department
Daily Work Record

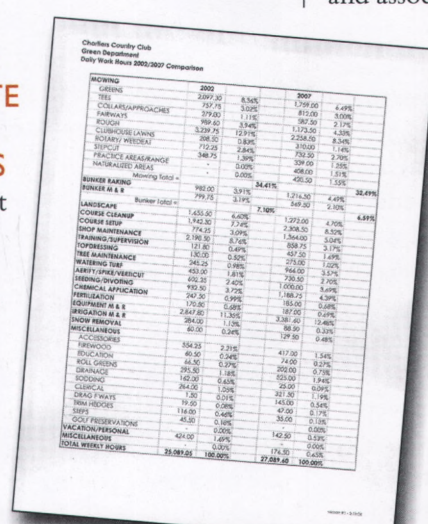
USING THE DATA: THE EVOLUTION OF THE MAINTENANCE PROGRAM

Comparisons of labor usage for 2002 and 2007 showed that time spent mowing greens was reduced by about 2% of total labor hours, which was a 16% reduction for the annual total amount of time spent on that task. However, greens rolling activity was increased by 0.8% of total labor activity, which equated to a 77% increase in annual labor time for the task. This quantifies a change in management philosophy to roll more and mow less, an industry trend that we have adopted here at Chartiers Country Club. The information provides guidance for the future as we receive requests to intensify putting green maintenance. We can predict the cost of increased rolling with increased mowing, but more importantly, we can present programs in a way that allows decisions to be made based on economics, not emotion.


Chartiers Country Club
Green Department
Week Hours 2007

USING THE DATA: FORMULATE FUTURE PROGRAMS

Knowing what things cost is the only way to forecast our golf course maintenance budget. Tracking labor use, coupled with time studies, allows us to estimate the cost of future programs and maintenance objectives. For instance, we looked to improve the presentation and playability of the intermediate rough adjacent to fairways, and we know how much our current maintenance programs cost. We trialed a demo mower that looked like a good acquisition, but by accumulating field data we found that, while a new mower may provide a better quality of cut, we projected that we would need to mow one to two more times per week. Totaling the cost of program adjustments (fertilizer, pest control, and associated labor to implement), provided us a good estimate of how our budget would be impacted.


Chartiers Country Club
Green Department
Daily Work Hours 2002/2007 Comparison

CONCLUSION

Collecting and building labor **data** records from your operation will be very worthwhile. The **knowledge** you gain can be used to generate the **power** you need to make better decisions and exceed golfer expectations.

DARRIN M. BATISKY *is the golf course superintendent at Chartiers Country Club in Pittsburgh, Pa.*

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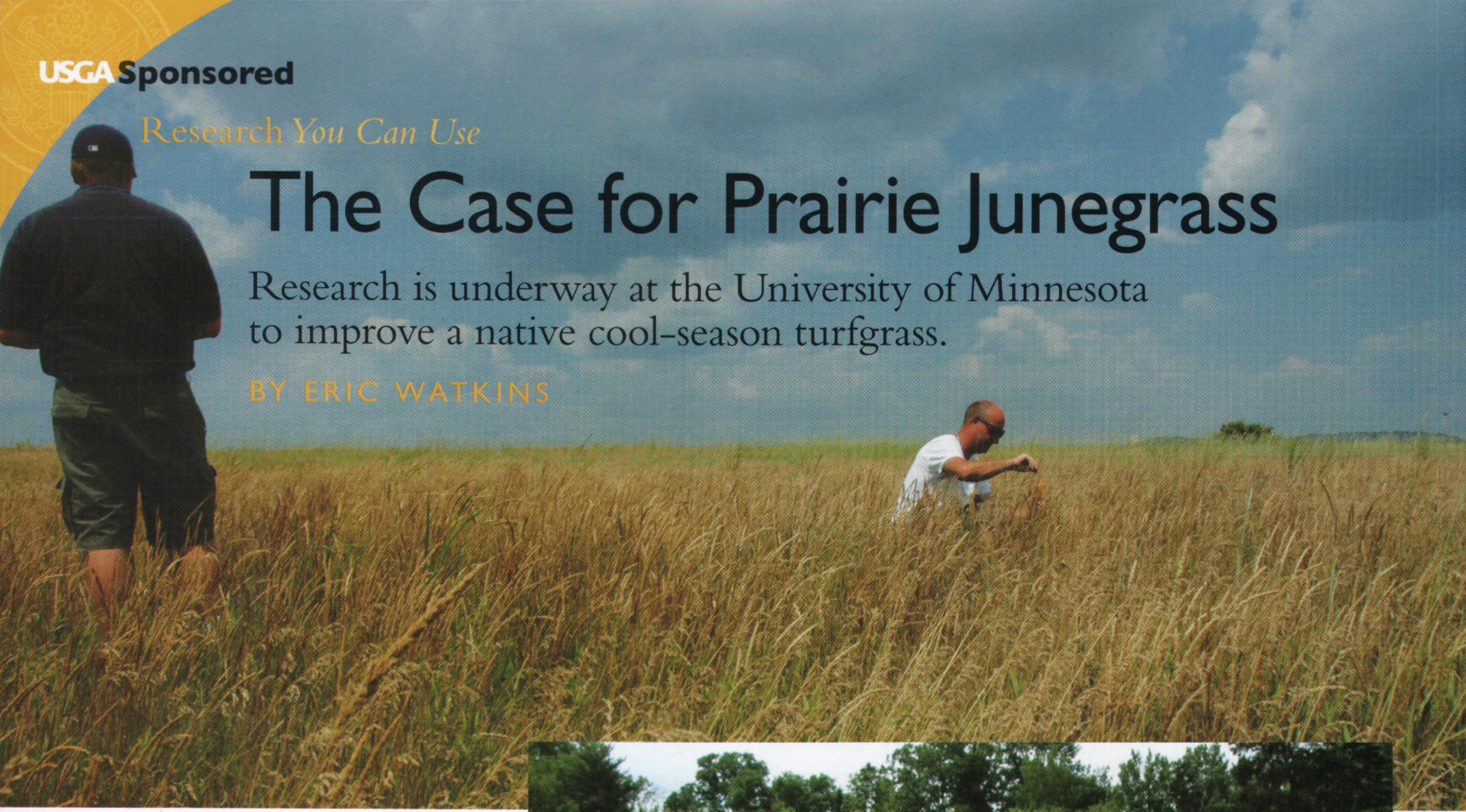
Research You Can Use

The Case for Prairie Junegrass

Research is underway at the University of Minnesota to improve a native cool-season turfgrass.

BY ERIC WATKINS



Collecting prairie junegrass in southeastern Minnesota.

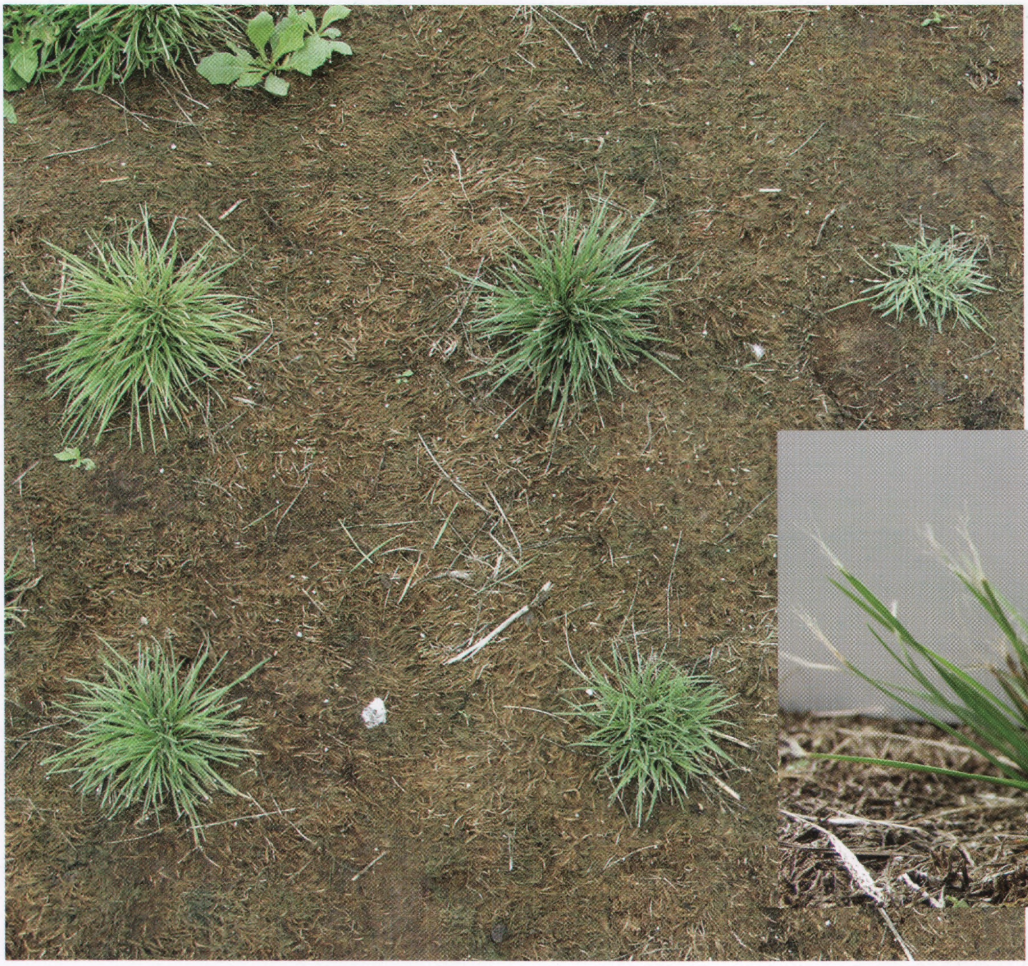
OBJECTIVE

To determine the genetic potential of native prairie junegrass (*Koeleria macrantha*) germplasm for use as a low-input turfgrass.

Start Date: 2007
Project Duration: Three years
Total Funding: $30,000

Grass species that are native to North America may be better able to cope with our environment and could lead to overall reductions in fertilizers, pesticides, and water. Prairie junegrass (*Koeleria macrantha*), which is native to the Great Plains of the United States, has shown the potential to be successfully used as a turfgrass in lower-input environments. The species is widely distributed throughout much of the western United States and also can be found throughout much of Europe and Asia. Based on data that have been collected in recent years, this species appears to perform well in Minnesota under

The material for this prairie junegrass breeding nursery was originally collected in western North Dakota.



Preliminary results from the mowing study indicate that sufficient variation for many important turf traits exists in the USDA collection.

Poor mowing quality of a *Koeleria macrantha* genotype is exhibited by the lack of a clean cut and frayed ends.

low-input conditions (limited nitrogen application; no irrigation, fungicide, or insecticide applications).

Prairie junegrass has several attributes that would make it a useful low-input turfgrass in Minnesota, including tolerance of droughty and alkaline soils, tolerance of sandy areas, survival of low- and high-temperature extremes, and reduced growth rate. Barkoel was the first cultivar of this species specifically developed for use as a turfgrass. However, this cultivar was developed with ecotypes from Europe. We propose the development of a cultivar using germplasm native to North America.

An economically viable, seeded cultivar must be able to produce sufficient quantities of seed. Non-selected populations of the species can produce seed for four or five years. Collections of natural ecotypes made in 2005 suggest that individual genotypes may possess the ability to be highly productive. At this time, it is unknown if it can produce economically adequate amounts of seed.

In order for a cultivar of this species to be used on a wide scale, two criteria must be met: 1) the cultivar must possess adequate turfgrass quality in medium to low-maintenance management situations, and 2) the cultivar must possess adequate seed production traits so that a sufficient supply of seed can be produced at a reasonable cost.

We have collected native prairie junegrass germplasm from Minnesota, South Dakota, North Dakota, Colorado, and Nebraska. These germplasm collections have been established in breeding nurseries, and in some cases, experienced one cycle of selection. We have established several spaced-plant evaluations that will be used to determine the genetic variation present in our populations for various turfgrass and seed production characteristics.

In 2007, two experiments were established in both St. Paul and Becker, Minn. The first experiment evaluated the USDA collection of *Koeleria macrantha* for seed production potential in Minnesota. The second experiment evaluated the same collections for turf potential as mowed spaced plants.

The seed production study is now complete, and we found significant variation among accessions. Collections that showed high levels of seed production potential included germplasm collected in Iowa. Collections with low levels of seed production were generally from areas of southwestern Asia. Based on these results, we will place additional focus on the inclusion of local collections in our breeding program in order to improve the seed production potential of the species.

CONNECTING THE DOTS

An interview with Dr. Eric Watkins *regarding the work at the University of Minnesota to develop prairie junegrass as a turfgrass.*

Q: *One of the reasons you chose prairie junegrass as a candidate for turfgrass development is the fact that it is native to North America. However, this grass has a very broad geographical distribution globally, as well, extending across Europe, most of temperate Asia, and even to the Indian sub-continent. What was it about prairie junegrass that most impressed you and suggested it might be a good candidate to develop into a turfgrass?*

A: The broad distribution of the species suggests that it might possess a wide range of tolerances to extreme environmental conditions such as extreme heat or cold. The distribution of the species also presents great opportunities for germplasm collection.

Q: *If you are successful in developing prairie junegrass as a turfgrass, what niche do you see it occupying, and what turfgrasses currently occupying that niche would it have to compete with?*

A: This would be a grass for use in lower-input areas that receive significant sunlight. Golf course roughs, city parks, and home lawns in Minnesota primarily consist of Kentucky bluegrass and perennial ryegrass, species that can be considered high input. Many turf managers and homeowners are looking for lower-input options in these types of areas. Other underutilized turfgrasses, such as hard and chewings fescue might also be able to replace higher-input species in these situations.

Q: *As a grass species that grows well on sandy, drought-prone soils, prairie junegrass might seem like a likely candidate for low-maintenance, non-irrigated sites. However, does prairie junegrass's poor performance on heavy soils, wet soils, or heavy shade limit its usefulness for golf course roughs?*

A: That's an excellent question. I'm not sure we have enough data to say that improved cultivars of this species would do poorly in all of the situations you mention. If shade-tolerant cultivars cannot be developed, mixing with low-input shade-tolerant grasses may provide a solution for golf course roughs with a mix of sun and shade.

Q: *According to what I've read about prairie junegrass, also referred to as crested hair grass, it is one of the first grasses to green up in the spring, but it will go dormant in hot, humid areas. To what extent do you think that would limit its useful range?*

A: This is a major concern that we hope to address in our breeding program. We have observed some variability in summer dormancy in our germplasm, and we hope to select material that maintains a green color throughout the summer. Summer dormancy is an important survival mechanism, so selecting against that trait could cause other problems.

Q: *Do you think that the gray-green color of prairie junegrass's leaves represents a marketing obstacle in this country, where consumer preference clearly favors a dark green appearance?*

A: As consumers continue to demand lower-input turfgrasses, there will need to be a shift in expectations. If a high-input turfgrass cultivar is growing in a non-irrigated area, its performance will be much reduced compared to growth under ideal conditions. Focusing on that difference, rather than the quality difference when both are grown with high inputs, should be convincing to most turf managers and other consumers.

Q: *It sounds to me that prairie junegrass turfgrass cultivars would most likely occupy the same niche as tall fescue. Is that the way you see it? Are there characteristics about prairie junegrass that would make it a better choice than tall fescue for certain situations?*

A: Not necessarily. Although we are encouraging more turf managers to utilize tall fescue in Minnesota, the species can be damaged by extended ice cover and can experience some winterkill during the first winter after a fall seeding. Tall fescue is a drought-avoidant grass, but it still requires more water than would be desirable in a low-input situation. An improved prairie junegrass cultivar would ideally use very little water compared to other cool-season turfgrasses, and it would not have any winter hardiness issues in Minnesota and similar climates.

Q: *A quick check on the Internet reveals that prairie junegrass is actively marketed as an ornamental grass, presumably because of its large inflorescence while still being a relatively short (<2 feet tall) open prairie species. When you go on collecting trips, is it these showy seed heads that most easily lead you to stands of prairie junegrass?*

A: Yes, the seed heads are very distinctive and make collecting much easier. In areas where we have collected, the species is not widespread, so this trait helps with quick species identification.

Q: *Prairie junegrass is one of the most widely distributed native grasses in North America. What have you learned so far in your selection and development process that would encourage or discourage you about this native species?*

A: I am very encouraged by the seed production potential of this species. Although there are several characteristics that are going to be a challenge to improve (mowing quality, summer dormancy, establishment rate), the variability we have seen in our initial collections indicates that an aggressive germplasm improvement program can be successful.

Jeff Nus, Ph.D., *manager, Green Section Research.*

Preliminary results from the mowing study indicate that sufficient variation for many important turf traits exists in the USDA collection. Of particular interest to our program are differences in mowing quality and the ability to maintain green color through summer stress periods. The mowing study will continue through 2009, and top-performing accessions will be integrated into our breeding program.

SUMMARY POINTS

- Native prairie junegrass, *Koeleria macrantha*, has characteristics that could make it useful as a low-input turfgrass.
- Great diversity exists in public collections of *Koeleria macrantha.*
- Local collections will result in improved seed production characteristics.
- Integration of traits from diverse germplasm should be effective in the development of a low-input cultivar.

RELATED INFORMATION

http://turf.lib.msu.edu/ressum/2007/38.pdf

Dixon, J. M. 2000. Koeleria macrantha (Ledeb.) Schultes (K. alpigena Domin, K. cristata (L.) Pers. Pro parte, K. gracilis Pers., K. albescens auct. non DC.). Journal of Ecology, 88:709-726.

Eric Watkins, Ph.D., *assistant professor, Department of Horticultural Science, University of Minnesota, St. Paul, Minn.*

On Course *With Nature*

Planting the Seed

Native tree seeds collected from Peel Village Golf Course enhance the local environment.

BY CHRIS RICKETT AND FRANK MERRAN

Unlike most restoration projects, volunteers from the Brampton Horticultural Society, Chinguacousy Garden Club, and the Etobicoke-Mimco Watersheds Coalition collected and sorted seeds by tree species from the Peel Village Golf Course.

During the fall of 2006, volunteers from the Brampton Horticultural Society, Chinguacousy Garden Club, and the Etobicoke-Mimico Watersheds Coalition scoured a woodlot at the Peel Village Golf Course to collect native tree seeds for planting. Numerous species of seeds were collected, including shagbark, downie, butternut, and bitternut hickory; bur and red oak; along with sugar maple and basswood; to plant in a one-acre forest restoration area on the golf course.

The partnership between the Toronto and Region Conservation Authority (TRCA) and Peel Village Golf Course is part of a broader plan that includes a forest restoration project for habitat along the Etobicoke Creek at the golf course and in the City of Brampton, Ontario, Canada. Unlike most restoration projects that plant saplings, this particular site utilized tree seeds and recreated the natural pit-and-mound micro-topography of a mature forest. Pit-and-mound typically results where trees fall, creating pits where their roots once sat and mounds where their bio-mass breaks down. This pattern was simulated by gouging out small pits with an excavator and leaving adjacent mounds. With a microhabitat created that could support vernal pooling and a diverse number of species, volunteers planted the seeds they collected in the pits and mounds.

Fast forward to the summer of 2007 and the restoration area has seen a number of tree seedlings burst forth. Oaks, which have had a hard time reproducing in the area, have been the most successful, with each pit-and-mound having on average three or four red or bur oak seedlings. Two black walnuts were also found, along with some sugar maples, but none of the hickory seeds were successful.

Pit-and-mound techniques were used to simulate the natural micro-topography associated with many of the tree species identified at Peel Village Golf Course.

While planting from seedlings means taking a longer view of restoration, direct seeding produces plants that are often much more drought-tolerant than planted saplings, as their taproots will immediately grow down from the germinating seed. To augment habitat opportunities and provide some additional natural cover, in the spring of 2007 volunteers complemented the sprouting seeds by surrounding the pit-and-mound areas with bare-root native tree and shrub saplings. During this spring planting event, volunteers also helped develop a butterfly meadow on the golf course. A half-acre plot was filled with black-eyed susans, wild bergamot, butterfly milkweed, wild strawberry, hairy mountain mint, and a number of different asters. The site has been so successful that within a few short months the new butterfly area was teeming with butterflies and insects, with some of the asters already measuring three feet high!

Overall, the work at the Peel Village Golf Course has utilized community partnerships, the resources of course management, the City of Brampton, and TRCA to lay a great foundation for expanding and enhancing the natural systems within the Etobicoke Watershed. Its success has planted the seed for a future of an improved environment within the community.

UPDATE

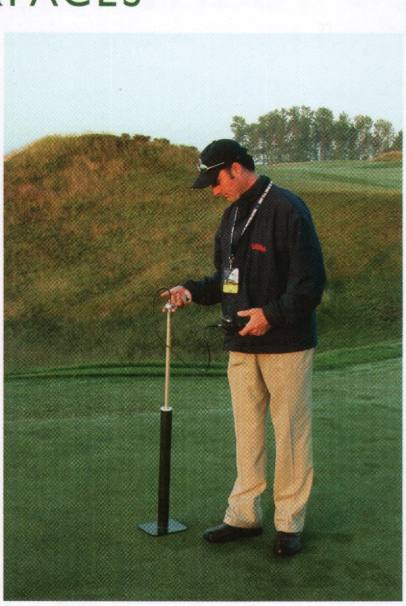
In May of 2008, 45 people came out for the annual spring planting at Peel Village Golf Course. Employees from Chrysler, members of the Chinguacousy Garden Club and Brampton Horticultural Society, along with friends from Eco Ambassadeurs du Monde worked hard to expand the existing butterfly gardens with an additional 2,000 native wildflowers. The butterfly garden planting event included a barbeque and provided an excellent opportunity to learn about the importance of butterflies and the many types of wildflowers that can be found locally. Plantings included: wild columbine, hairy beardtongue, sky blue aster, and butterfly milkweed. This past September, Peel Village Golf Course hosted a fall planting event, inviting friends and neighbors to plant native trees and other natives around the course.

Chris Rickett *is the watershed planning project manager for the Watershed Management Division of Toronto and Region Conservation. For more information on Toronto and Region Conservation, visit* www.trca.on.ca. Frank Merran *is the manager of Peel Village Golf Course, a municipal course owned and operated by the City of Brampton in Ontario, Canada. It has been designated as a certified Audubon Cooperative Sanctuary since 1998. For more information about the course, please visit* www.brampton.ca/peel_village/home.taf. *For more information on the Audubon Cooperative Sanctuary Program, please visit* AudubonInternational.org.

News *Notes*

TruFirm: NEW IMPACT MEASUREMENT AND ANALYSIS SYSTEM FOR GOLF COURSES AND SPORTS FIELD SURFACES

What is TruFirm? Developed by the United States Golf Association for use at USGA championships, TruFirm is a system that allows the golf course superintendent to measure and analyze the firmness of turf and bunker sands over the course of a tournament, the playing season, or many years. TruFirm has been used to gauge the firmness of putting surfaces, fairways, and bunker sands at every U.S. Open since 2005 and every 2008 USGA Championship. In 2008, TruFirm was used at two men's major championships.



Why measure firmness? Having an objective evaluation of firmness is an important tool for the golf course superintendent. Measurements can be used to provide consistent conditions over key areas of the course. The TruFirm System will help identify areas where playing quality has been adversely affected by overwatering and/or excessive buildup of organic matter. As corrective practices are implemented, TruFirm provides a means of determining the progress that is made over time. The TruFirm System also can be used to determine firmness of the green profile prior to seeding and to identify the potential for buried lies in bunkers.

Using the TruFirm System. Taking measurements with the TruFirm System is as simple as raising and dropping the hammer. Data and GPS information are stored and displayed on the handheld computer and are color coded according to your desired firmness levels. Easy-to-follow graphs allow you to review changes in firmness over time, at specific locations, or over the entire course, as well as hole-to-hole variation.

Data collected on the handheld can be downloaded to your desktop or laptop PC so that printable reports can be generated and further analysis conducted.

Maintaining the desired firmness for important turf areas — for an event, season, or year after year — depends on managing water usage and controlling the buildup of organic matter. TruFirm gives the superintendent an objective measure of turf firmness to aid in irrigation and maintenance decisions.

Purchasing the TruFirm System. The TruFirm System is available from the USGA at a cost of $8,700, plus tax where applicable. The price includes the TruFirm System (hammer, handheld computer, GPS, all cables and chargers, software for handheld and desktop/laptop PCs) in a waterproof case, along with a Stimpmeter.® Purchase of the TruFirm System in the U.S. also includes an on-site visit by a USGA Green Section agronomist, who will provide training on the use of the TruFirm and discuss what the measurements mean to you. The purchase price of the TruFirm System also includes updates to the software and technical support for one year.

For more information, call (908) 470-5009.

PHYSICAL SOIL TESTING LABORATORIES

The following laboratories are accredited by the American Association for Laboratory Accreditation (A2LA), having demonstrated ongoing competency in testing materials specified in the USGA's Recommendations for Putting Green Construction. The USGA recommends that only A2LA-accredited laboratories be used for testing and analyzing materials for building greens according to our guidelines.

Brookside Laboratories, Inc.
308 Main Street, New Knoxville, OH 45871
Attn: Mark Flock
Voice phone: (419) 753-2448
FAX: (419) 753-2949
E-Mail: mflock@BLINC.COM

Dakota Analytical, Inc.
1503 11th Ave. NE, E. Grand Forks, MN 56721
Attn: Diane Rindt, Laboratory Manager
Voice phone: (701) 746-4300 or (800) 424-3443
FAX: (218) 773-3151
E-Mail: lab@dakotapeat.com

European Turfgrass Laboratories Ltd.
Unit 58, Stirling Enterprise Park
Stirling FK7 7RP Scotland
Attn: Sharon Bruce
Voice phone: (44) 1786-449195
FAX: (44) 1786-449688

Hummel & Co.
35 King Street, P.O. Box 606
Trumansburg, NY 14886
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Voice phone: (607) 387-5694
FAX: (607) 387-9499
E-Mail: soildr1@zoom-dsl.com

Hutcheson Technical & Soil Services
8 West Street, South
Huntsville, ON, Canada, P1H 1P2
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Voice phone: (705) 788-0407
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Consistency in Bunkers . . . What Does It Mean?

"The risk of going into a bunker is self-imposed, so there is no reason why a player should condemn a bunker as unfair."

— C. B. Macdonald

BY BUD WHITE

Consistency is a terrible word! That comment may pose a real question in your mind at first, because we all know putting surface consistency is *the* most important measurement for putting greens, superior even to putting speed. The term *consistency,* when applied to bunkers, may be the most impossible and contradictory measurement in golf today. In fact, over the last four to five years, the travels of the USGA Green Section staff have focused more and more on the search for the holy grail of bunker maintenance.

On many occasions our USGA Turf Advisory Service visits have devoted a disproportionate amount of time directed toward bunker consistency. It is important for golfers to understand why this term is inapplicable to bunkers, except in three key areas:

1. All bunkers should be raked with the same consistency.

2. Sand depth on the bottoms and on the slopes should be consistent.

3. The sand composition should be as close to the same consistency as possible.

The first two points are a given in terms of proper maintenance of bunkers. However, the third can vary, based usually on the amount of washing that occurs in a bunker from rain or irrigation. When sand washes down a bunker slope, underlying soil is exposed and contaminates the sand, making it poorly drained and much firmer. In such a situation, the drain is dug up and exposed; it is often completely clean and actually dry because the contaminated sand prevents water from getting to the drainpipe.

Bunkers are exposed to differing amounts of moisture, with greenside bunkers usually having greater moisture than fairway bunkers because of the additional exposure to irrigation around greens versus fairways. It is impossible to balance the amount of irrigation exposure to bunkers from this difference alone. Yet, the amount of moisture content in a bunker is usually the greatest single measure golfers use to compare bunker consistency, and consequently its firmness or softness. Stop and think how impossible it would be to balance the irrigation exposure of every bunker on a golf course.

I encourage golf courses to have a town hall meeting and allow the superintendent to discuss how the bunkers are maintained and what his budget and labor force allow him to do. Consistency should be emphasized in the areas of sand depth and raking techniques throughout the course. Today, many golf courses are spending more man-hours on bunkers than they are on putting greens. This is totally crazy because bunkers are *hazards.* The degree of bunker perfection many golfers seek today is impossible to obtain. Hopefully, after considering these factors, the word *consistency* as it relates to bunker maintenance will become less of an issue. If it doesn't, then you are not looking at maintenance in a realistic way and you probably need a few more lessons from a golf professional so you can make the bunker shot instead of complaining about *consistency*!

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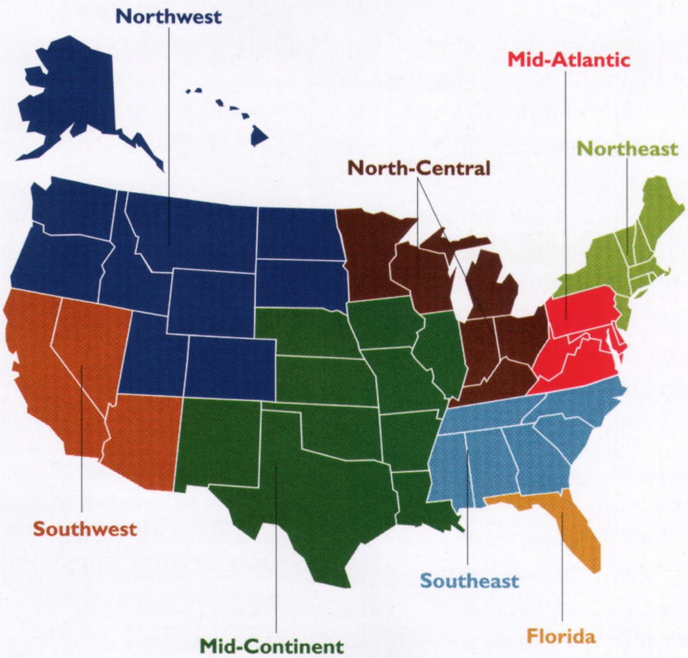

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Turf *Twisters*

Q: We purchased very expensive sand for our bunkers. Any tips regarding how to keep the sand clean? (Wisconsin)

A: There are many sources of bunker sand contamination, such as erosion during washouts, deep tillage with motorized rakes, etc. Courses have had relatively good success using the new generation of bunker liners to prevent soil contamination from the base of the hazard. An often overlooked source of contamination is organic debris from grass clippings and leaves. Make an extra effort to blow clippings and leaves out of the bunkers before tilling the sand with rakes.

Q: I am looking for new ways to communicate with and educate the club's membership. Signs, newsletters, and even e-mails seem to get lost in the shuffle when it comes to things like communicating the need for frost delays, aeration, and topdressing, etc. All are critical to the agronomic success of our course, but I feel like everyone has grown numb to hearing "superintendent talk," as they now call it. Many think these agronomic issues are just my personal ideas. Can you offer any suggestions? (Kansas)

A: It sounds like you are doing more than many in regard to communication. Unfortunately, it is not uncommon for members to become numb to messages that are agronomic in nature. To help communicate these points, try using the new animations on the USGA's web page. These brief video clips cover a variety of topics, including ball mark repair, course etiquette, bunker consistency, frost delays, hand watering, and putting green aeration. The animations are available free of charge. A CD, *An Animated Journey from Tee to Green*, also is available for purchase, and several clubs have had great success playing the animations in the clubhouse, pro shop, or wherever golfers congregate.

Q: I oversee the irrigation of several golf courses with recycled water. Can you offer guidance on the type of notification a golf course should post to inform the public that the course is irrigated with recycled water? Additionally, do you have any best management practices regarding watering times, nutrient considerations, ponding, and runoff control for the use of reclaimed water?

A: Alerting golfers and neighbors of recycled water use usually involves signs on the perimeter entrances and throughout the grounds, simply stating that recycled or non-potable water is used for irrigation. Typically, the individual heads, quick couplers, and valve boxes are marked or use purple components to make users aware that non-potable water is in these systems. All major irrigation manufacturers supply these components for their products.

Best management practices are specific to each facility. Existing soils and the recycled water used must be continually tested to reassess the needs of the turf and soil. The nitrogen component in the water must be accounted for in the nutrient program. Also, bicarbonate levels typically are higher, and these and other salts may need to be leached periodically to move salts below the rootzone in the soil profile. Changes in cultural practices sometimes are required to help with the salt leaching. Each golf course superintendent must gather this information and then determine the proper water management and fertilizer and pest control plan for the golf course.