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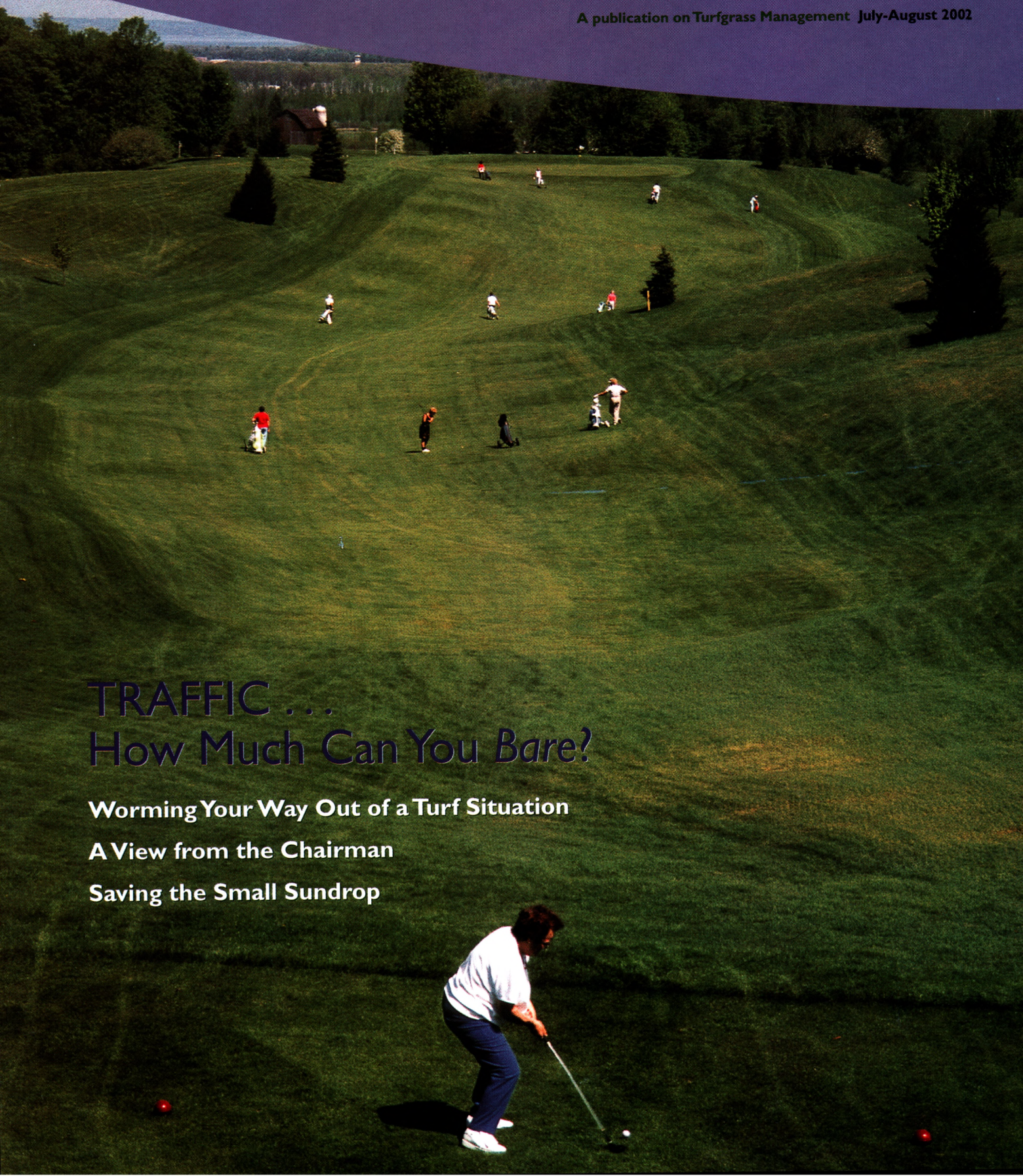

TRAFFIC . . . How Much Can You *Bare*?

Worming Your Way Out of a Turf Situation

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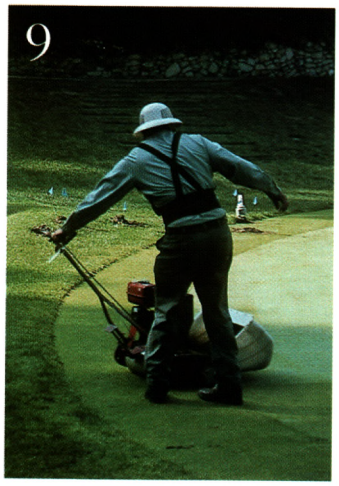


Cover Photo
The wear and compaction caused by concentrated foot traffic and carts are serious concerns at popular, heavily played courses.

A well-designed network of paved paths can keep the course open to carts during wet weather and help maintain a smooth flow of traffic through the course. Curbing further enhances the effectiveness of cart paths — assuming, of course, that the golfers abide by the rules of the road.

TRAFFIC . . .

HOW MUCH CAN YOU *BARE*?

Wear and compaction can leave you with unsightly bare spots.

BY BOB VAVREK

A general definition of traffic as it pertains to golf turf might be *the movement of people and vehicles across the playing surfaces.* When all is said and done, without traffic, most golf courses would go out of business. After all, the effects of foot and cart traffic on the turf are directly related to the amount of play. There is no free golf, and green fees, membership dues, and cart revenues support golf course operations. Excessive traffic, however, can have a detrimental effect on the quality of the playing surfaces.

Concentrated traffic is a multi-component stress to the turf. According to Beard (1973), traffic results in four problems: (1) turfgrass wear, (2) soil compaction, (3) soil displacement or ruts, and (4) turf removal or divots. The most apparent effects of traffic are ruts, divots, and direct wear injury to the turf plants. Compaction is often considered the *hidden effect* of traffic because it affects the underlying soil. Soil compaction may not be visible, but it often alters the soil physical properties in a manner that is detrimental to turf growth. This article discusses how compaction affects soil physical properties, turf growth, and the quality of playing conditions, along with various techniques for relieving or preventing compaction.

Deep-tine aeration can relieve compaction found beyond the reach of conventional core cultivation operations.

COMPACTION

Soil compaction is defined as the pressing together of soil particles, resulting in a more dense soil mass with less pore space (Carrow and Petrovic, 1992). Back in Soils 101 we learned that a typical silt loam soil capable of supporting healthy plant growth would be composed of 50% solids (45% mineral, 5% organic matter), 25% air-filled pore space, and 25% water-filled pore space. Apply pressure or compaction to this soil and the balance between solids, air, and moisture is altered. Soil aggregates break down and individual soil particles are squeezed and shift into closer alignment. The ratio between small water-holding pores and large air-filled pores increases. The soil becomes denser and holds more water due to the increase in small pores.

A little compaction may actually improve growing conditions for turf on a sandy loam soil by increasing the moisture-holding potential of an otherwise droughty soil. However, relatively few courses outside of Florida are built on sand or sandy loam soils. Most courses are built on soils that contain a significant amount of silt and clay. The texture of the soil is one factor that determines the potential for compaction. The higher the fraction of silt/clay in the soil, the greater the potential for compaction.

Other factors that influence the potential degree of compaction for a particular soil include:

- Particle size distribution — Soils that have a wide particle size distribution are more susceptible to compaction than soils that have a narrow particle size distribution. For example, when most of the particles of a sandy soil are about the same size, the root zone resists compaction because the individual sand particles touch each other and a bridging action prevents a shift in the pore size distribution.
- Soil moisture — Dry soils are more resistant to compaction than wet soils. The water acts as a lubricant, and soil particles shift under pressure and orient themselves in a manner that reduces large pore space. As a result, the ratio of small pore space to large pore space increases.
- Turf density and thatch — The amount of living or dead plant tissue that exists on the surface of the soil can buffer or cushion the effects of compacting forces. Weak, thin stands of turf are highly susceptible to compaction.

A comprehensive review of how compaction affects turfgrass growth can be found in Carrow and Petrovic (1992). Severe compaction affects turfgrass growth in the following ways:

- Altered root distribution and root dysfunction. Most turfgrass roots growing in heavily compacted soils are found near the surface. The mechanical impedance of compacted soils to root growth is partially to blame for the shallow rooting. Other potential causes of shallow root growth include the production of ethylene by roots subjected to compaction, resulting in the growth of shallow adventitious roots. Low oxygen levels in compacted soils also discourage deep rooting and limit root water uptake.
- In various studies of turfgrass growing in heavy soils, compaction has caused decreased shoot density, rhizome/stolon development, and clipping yield. In contrast, moderate compaction can increase topgrowth of turf growing in sandy soils.
- Nutrient uptake is altered in compacted sites probably due, in part, to the effects of compaction on root growth.
- Reduced water uptake can occur under compacted conditions.
- Turf growing on compacted soil can have reduced carbohydrate reserves and, in turn, have less ability to recover from stress.
- Compacted soil has a greater capacity to hold moisture. As a result, the soil takes longer to warm up during the spring, and the excessively moist rootzone inhibits root growth. Spring green-up can be delayed, and soft, soggy surfaces provide golfers inconsistent playing conditions.

From the golfer's viewpoint, a compacted soil equates to a less resilient playing surface. This may mean a little more roll in the fairways, but rock hard tees and greens. Golfers often complain that *the greens don't hold* when an inability to put backspin on the ball is to blame. On the other hand, severe compaction to a soil-based, push-up green can create an unfair surface that even a skilled player has difficulty holding.

MINIMIZING THE EFFECTS OF SEVERE COMPACTION

In general, two management strategies are employed to address the myriad of problems associated with growing turf on compacted soil:

- Alleviate the compaction that already exists through various cultivation techniques.
- Modify the soil physical properties and reduce or redistribute traffic to prevent further compaction from occurring.

Worst-case scenario . . . allowing golf carts to roam free on a soft, wet course.

CULTIVATION

In some respects, the constant process of root growth and dieback can be considered a passive, but important form of cultivation. Although compaction limits root growth, even a little root growth through a tight soil is a step in the right direction. When turf roots die and decay, the channels often retain their integrity and help reestablish large pore space. Microbes and the by-products of the plant decaying process are sources of the glue that bonds individual soil particles together to create relatively stable aggregates, creating more pore space.

The mechanical action of freezing and thawing also helps relieve soil compaction, if the playing surfaces are not continually subject to traffic associated with winter play. Natural processes like freeze/thaw cycles and root growth/death are most effective when the compacted site is left fallow — a condition that never occurs on golf courses. Consequently, more aggressive forms of cultivation are required to improve growing conditions on heavily compacted sites.

HOLLOW/SOLID-TINE CULTIVATION

Hollow or solid-tine cultivation is the universally recognized maintenance practice employed to loosen compacted soils. Most golfers are intimately familiar with this operation, and some respond with the familiar complaints regarding surface disruption. Practically all courses employ some form of hollow- or solid-tine aeration each season on greens and other areas.

Compaction caused by foot traffic, carts, or maintenance equipment on golf courses generally occurs within an inch of the surface. Compaction deeper into the soil profile can be caused by excessive earthmoving and grading operations with heavy equipment during the construction phase. However, surface compaction is, by far, a more common problem than deep compaction.

Standard punch-type coring units are designed to affect the upper 2 to 4 inches of the soil profile. The holes enhance the movement of water into the soil, and the holes encourage root growth. Removing aeration plugs and topdressing with sand provides an opportunity to modify the physical properties of the soil.

Removing a core of soil from a playing surface cannot help but reduce the bulk density of the

underlying soil profile. Whether or not solid- or hollow-tine aeration actually relieves compaction is debatable, based on the conflicting results from various cultivation studies. Petrovic (1979) found a zone of compaction immediately surrounding a hole produced by hollow-tine cultivation. This cultivation-induced compaction was short lived and was generally found very close to the hole/soil interface. The greatest compaction occurred directly under the hole, and it persisted long after the sidewalls of the holes had collapsed. This explains how a thin zone of compaction can sometimes develop in greens that are cultivated to the same depth year after year, a phenomenon similar to the plow pan that can develop in agricultural soils.

Others have found core cultivation to increase water infiltration and root growth. Considering the inconsistent nature of the research results, varying the depth of cultivation penetration whenever possible is recommended. Standard hollow-tine cultivation of heavily trafficked playing surfaces has been and should remain a cornerstone of the foundation for any sound golf course maintenance program.

Vertidrain and deep-drilling cultivation makes the process of varying the depth of penetration as simple as changing a setting on the equipment. These operations can have a beneficial effect on deep zones of compacted soils that exist beyond the reach of standard cultivation equipment. Water injection also can be employed to relieve deep compaction and increase the infiltration rate of water into the soil without causing excessive disruption to the playing surface.

Various spiking units also are available to improve water infiltration without causing excessive disruption. The primary advantage of using a spiking unit across high-use turf is the speed at which the operation can be performed.

Course design can have a significant impact on traffic patterns. This greenside bunker funnels traffic across a narrow strip of turf, resulting in a narrow strip of dirt.

PREVENTING COMPACTION

COURSE DESIGN

One of the simplest ways to minimize the detrimental effects of concentrated traffic is to design the course in a manner that spreads the wear across as much surface area as possible. For example, large bunkers, mounding, or trees that block the entrances and exits to greens tend to concentrate traffic onto localized areas of the course.

CART PATHS

A well-designed network of paved paths provides an opportunity to use carts during wet weather without damaging the turf and compacting the soil. A number of articles can be found in past issues of the *Green Section Record* that describe in detail the benefits of cart paths.

MINIMIZING PLAY DURING AND IMMEDIATELY FOLLOWING WET WEATHER

As mentioned earlier, the susceptibility of heavy soils to compaction is directly related to the amount of moisture in the soil. Motorized carts are the primary culprits, but concentrated foot traffic across soft, wet soils can also cause compaction. Traffic needs to be redirected away from areas that have a history of sustaining damage during wet weather. A combination of signs and ropes/stakes helps protect these wet sites. Many courses need to be closed to motorized carts for an appropriate period of time after heavy rainfall events.

DRAINAGE

Wet soil is more vulnerable to compaction than dry soil. Consequently, improving surface and subsurface drainage, where necessary, will reduce the potential for compaction.

IRRIGATION

Controlling automatic irrigation carefully to eliminate wet areas is recommended. This may

require the installation of new sprinklers, more efficient nozzles, and new controllers, and on some courses irrigation systems may need to be completely replaced. Non-uniform irrigation patterns and the resulting overwatering that occurs will create wet spots that are more susceptible to compaction.

SOIL MODIFICATION

Heavy soil playing surfaces on greens, tees, and even fairways can be modified through an aggressive sand topdressing program. Routine core cultivation and core removal, followed by topdressing to fill the holes, is one of the most widespread and effective maintenance practices used

TURF TIRES . . . THE REST OF THE STORY

Ever have an equipment vendor extol the virtue of his wares with statements such as: "The low-pressure, smooth-tread, balloon tires on this 300-gallon sprayer create a footprint no heavier than a pull cart loaded with a set of clubs"? The conclusion you are meant to draw is that the sprayer, or any other large, heavy item of equipment outfitted with similar turf-type tires, will cause less compaction and wear to the turf than a pull cart.

Something about that statement always bothered me, particularly the thought of how heavy that sprayer would be when filled with water. There is a temptation to begin a debate by challenging that statement with a test. We both lie down on the fairway. Someone pulls a cart with clubs across my body and someone drives a loaded sprayer over the vendor. I win.

The fact is that a large, heavy piece of equipment is still large and heavy regardless of tire design. Granted, a fairway mower equipped with balloon tires will cause less wear and compaction to the playing surface compared to the same unit equipped with narrow tires. The large, soft tires spread the weight across a greater surface area and they should be used on turf maintenance equipment. However, research indicates that a wide tire on a heavy unit causes deeper compaction than a narrow tire on a lighter unit, even though the footprints are equal (Blackwell and Soane, 1981). Furthermore, spreading the weight across a greater area does just that — it subjects more area of soil and more turf plants to traffic.

The *equal footprint* argument almost holds water under static conditions — no movement of the cart or the sprayer. Begin traveling across the turf and all bets are off. Stopping, starting, turning, and spinning the tires will create abrasion and bruising to the turf and impart shearing forces to the underlying soil.

Carrow and Johnson (1989) studied the effects of golf cart tires on turf and found that the amount of wear is significantly increased when

Not sure how much wear carts cause to turf? A side-by-side comparison of no carts vs. heavy cart traffic leaves no doubt.

you turn the cart because the weight shifts to the outside tires. The speeds at which you travel across the turf and the vibration from the engine influence the amount of compaction that is generated by the traffic. The final line in this reference speaks volumes: "According to our study, traffic distribution and the sharpness of turns is more important than type of golf car or tire design in minimizing wear to golf course turf."

Obviously, the more you travel over the same area, the more wear and compaction affect the turf. To distribute the weight across a greater area and create a light footprint, more tires are placed on heavy equipment. More tires means more passes across the same turf and more traffic effects.

The bottom line is that turf-type tires should be used on golf course maintenance equipment whenever possible. Tires, though, do not magically transform a heavy sprayer or mower into a pull cart. If you don't believe it . . . take the challenge!

Cart paths should be well designed to encourage use by the golfers. This cart path is too narrow and located too far from the fairway.

on older push-up style soil greens to combat the detrimental effects of traffic. Similarly, high-quality greens often are topdressed with light, frequent applications of sand throughout the season. The intent is to develop a compaction-resistant rootzone and smooth the playing surface. Tees, too, are often placed on a similar cultivation and topdressing regimen.

An increasing number of courses are using sand to topdress heavy soil fairways. Specialized, high-capacity topdressing equipment is strongly recommended if substantial course acreage is targeted for soil modification.

SUMMARY

Soil compaction may be a hidden effect of excessive traffic, but the inability to see the problem does not lessen the detrimental effects of compaction on turf growth and development. Considering all the ways to prevent compaction described in this article, the one you can take to the bank is to limit traffic across the playing surfaces when the soil is wet. Cart revenues are important, but allowing carts access to a soft, wet golf course can cause short- and long-term damage to turf and soil far greater than the value of one day's worth of cart fees. A continuous cart path system is an excellent investment at courses where wet weather regularly would limit cart use.

How much traffic can you bare? Each course is different due to soil type, drainage, and many other factors. Keep the course dry, limit cart use during wet weather, alter traffic patterns wherever possible, and maintain an aggressive cultivation program to keep what you can't see, hidden compaction, from hurting you.

REFERENCES

Beard, J. B. 1973. Turfgrass: Science and Culture. Prentice-Hall, Englewood Cliffs, NJ.

Blackwell, P. S., and B. D. Soane. 1981. A method for predicting soil bulk density changes in field soils resulting from compaction by agricultural traffic. J. Soil Sci. 32:51-65.

Carrow, R. N., and B. J. Johnson. 1989. Turfgrass wear as affected by golf car tire design and traffic patterns. J. Amer. Soc. Hort. Sci. 114(2):240-246.

Carrow, R. N., and A. M. Petrovic. 1992. The effects of traffic on turfgrass. In: D. J. Waddington, R. N. Carrow, and R. C. Shearman, co-editors. Turfgrass. Agronomy. 32:285-330.

Petrovic, A. M. 1979. The effects of vertical operating hollow-tine (VOHT) cultivation on turfgrass soil structure. Ph.D. diss. Michigan State University, East Lansing.

BOB VAVREK, *agronomist for the North Central Region, wears a path to courses in Wisconsin, Michigan, and Minnesota with the intent of improving playing conditions for golfers.*

Research *You Can Use*

Worming Your Way Out of a Turf Situation

Development of an integrated pest management system to reduce earthworm casts.

BY P. A. BACKMAN, E. D. MILTNER, G. K. STAHNKE, AND T. W. COOK

Earthworm casting on golf course fairways is an extremely challenging turfgrass management issue that faces many golf course superintendents. For this reason, the Northwest Turfgrass Association and Western Canada Turfgrass Association funded a multi-year study to evaluate earthworm casting on golf course fairways. The initial phase of the project focused on identifying the earthworm species that causes casting damage and learning more about its biology. Phase two evaluated soil acidity, clipping removal, hollow-core aeration, and sand topdressing for effects on casting.

Casting occurs when earthworms ingest soil and leaf tissue to extract nutrients, then emerge from their burrows to deposit the fecal matter (casts) as mounds of soil on the turfgrass surface. There are no products developed or labeled specifically to control earthworm casting, and the effects of long-residual pesticides from past decades have worn off. The result has been an exponential increase in casting on golf course fairways over the last decade. Extensive earthworm casting interferes with proper maintenance practices, playabilty of the turfgrass surface, and the overall aesthetic value of the affected fairways.

The earthworm species depositing casts throughout the Pacific Northwest and much of the northern United States is *Lumbricus terrestris*, the common night crawler. Night crawlers build semi-permanent vertical burrows that can extend up to several meters deep in the soil. However, due to regular irrigation and constant food supplies (clippings and soil organic matter) associated with fairways, these earthworms tend to remain closer to the surface, migrating up and down in the soil profile with fluctuations in moisture content, soil temperature, and atmospheric pressure. Peak earthworm casting damage occurs during the cool, wet weather in the spring and late fall through winter, especially when conditions of stable low atmospheric pressure exist. The most severe casting damage occurs in late fall and winter when the recuperative ability of the turf is at a minimum.

Earthworm casts and mowing equipment don't always mix well together. The result can smother the nearby turf, resulting in poor playing conditions.

EFFECTS OF CLIPPING REMOVAL AND HOLLOW-CORE AERATION ON CASTING

Lumbricus terrestris feeds directly on decaying leaf clippings and organic matter in the soil. A study was conducted to evaluate clipping removal and hollow-core aeration as methods of reducing the food supply. The treatments were initiated in January of 1999 and continued for two years. Even though *L. terrestris* feeds directly on decaying leaf clippings, the results of the study showed that two years of clipping removal had no effect on reducing earthworm casting caused by *L. terrestris.* The spring and fall hollow-core aeration treatments also had no effect on casting after two years.

EFFECTS OF SOIL pH ON CASTING

The acidifying effects of certain fertilizers have been reported to reduce earthworm casting. A multi-year study evaluated fertilizer treatments of ammonium sulfate (AS) 21-0-0, ferrous sulfate ($FeSO_4$)(20%), dolomitic lime,

and Nitroform 38-0-0. Soil acidity was monitored at 0-2 cm and 2-6 cm. After two years of fertilizer treatment applications, there were some large decreases in the soil pH in the top 0-2 cm and 2-6 cm. The effects of increasing soil acidity had no impact on reducing casting. Likewise, an increase in casting was not observed after two years of heavy lime applications. The response curve of earthworms to various soil factors is not the same for all earthworm species. There are several species of earthworms that are much more intolerant of acidic conditions than *L. terrestris*.

EFFECTS OF SAND TOPDRESSING ON CASTING

It has been reported that the abrasiveness of sand particles and sand's susceptibility to drought influences both earthworm species composition and earthworm numbers in the soil. A topdressing study included treatments of high sand (1.5 inches of sand per year), low sand (0.75 inches of sand per year), and a control which did not receive sand. Six sand topdressing applications were made between May 30 and August 22, 2000. The high sand received .25 inch of sand per application, and the low sand .125 inch per application. The results of the sand topdressing are shown in Figure 1.

The first count after the treatments were in place was taken on September 15, 2000, and resulted in significant differences in casting among all three treatments. The high-sand plots were dramatically better than the low sand and the control. The significant reductions continued through the fall and winter casting counts (October 15, 2000, and March 10, 2001). Sand topdressing proved to be an effective method of reducing earthworm casting.

CONCLUSION

The issue of earthworm casting will continue to be a difficult management issue in the future. It is unfortunate that there are superintendents who face extreme pressure on this issue from golfers. After all, these earthworms prefer the same conditions that are required to maintain healthy turfgrass. For superintendents, it is extremely important to educate the parties involved on the biology of earthworms, benefits of earthworm activity, and the lack of products available for control.

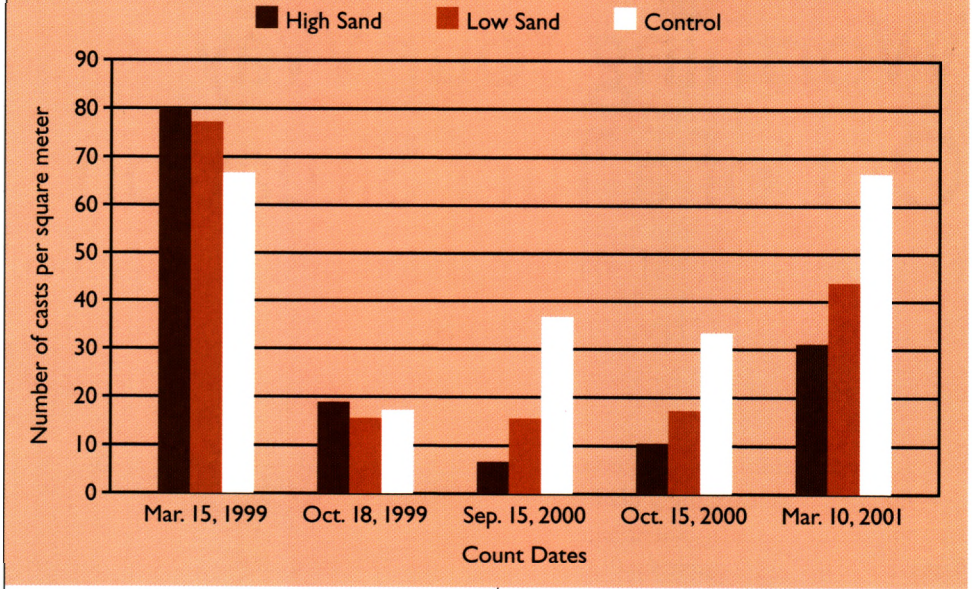
In attempting to manage earthworm casting on fairways, superintendents need a detailed map that identifies the areas most damaged by casting as well as areas with moderate casting. Casting severity is highly variable from fairway to fairway; even within a fairway there are heavily infested areas and areas with zero casts. Superintendents must know where their trouble areas are. The fact that *L. terrestris* earthworms have been reported to live for up to 6-9 years in the soil means that problems come back in the same place year after year, with casting severity expanding out laterally from those areas.

There are casting control strategies implemented on golf courses not discussed in this update, including physical removal of the worms by harvesting companies and applications of products that inhibit casting. These measures typically provide only short-term relief, and the legality of some of these applications is in question. We've learned through numerous field observations and the dramatic reductions in earthworm casting after one growing season that sand topdressing is a viable control strategy for earthworm casting. Sand topdressing requires a long-term commitment, as multiple applications are necessary. It also is very expensive and labor intensive. In most cases, sand topdressing and any other control strategies being implemented can be made with a spot treatment mentality. This emphasizes the need for an acccurate map.

Earthworm casting is an issue that inevitably will require some tolerance on the part of golfers and superintendents. We must remember that earthworms provide far more benefits to the soil/turf environment than they do harm. The earthworm's burrowing and feeding activity initiates thatch decomposition, stimulates microbial activity, makes particular plant nutrients more available, increases soil aeration, and in general improves overall soil quality.

PAUL BACKMAN *casts his lot in golf as the Executive Director of the Northwest Turfgrass Association and Western Washington Golf Course Superintendents Association.*

Figure 1
Effects of Sand Topdressing on Earthworm Casting Numbers



Collar ID

Identification of the proper maintenance strategies will improve this area of the golf course.

BY MATT NELSON

Look through the Rules of Golf and you will not find any mention of a collar. This section of the golf course falls into that all-encompassing category of "through the green." But ask any golfers and they immediately know the collar, or fringe, as that area of closely cut turf immediately surrounding the putting green. Although the width and height of cut vary among golf courses, all collars serve the important role of providing the golfer an intermediate surface between the putting green and surrounding rough. The collar helps prevent the player from being severely penalized for shots that barely miss or roll through the putting green. These small, distinct portions of the golf course are often taken for granted, but collars can cause golf course superintendents real grief in certain situations. Proper construction, turfgrass selection, and maintenance programs safeguard turf health and playing quality, while streamlining maintenance efficiency.

AVOID BUILT-IN PROBLEMS

When building new putting greens, the collar should be built as part of the green (1,2). Utilizing the same rootzone architecture helps minimize management differences between the putting green and collar. With USGA greens, the putting green cavity wall should be vertical or very steeply sloped at the outside edge of the collar. Burying wire along the perimeter of the cavity enables accurate mowing contours to be maintained over time.

Among the most common construction problems facing collars is the feathering of rootzone mix at the perimeter of the green, which commonly results in shallow rootzone mix below the collar turf. This can lead to an overly wet rootzone that offers poor turfgrass vigor, poor traffic tolerance, and difficult irrigation management. Maintain a vertical cavity wall during construction to help assure a uniform rootzone mix depth. Also, install smile drains along the edge of the cavity at any low gradient.

Another construction oversight is the failure to install a wicking barrier in arid or stressful climates. A wicking barrier is a plastic liner installed along the perimeter of the putting green cavity to prevent moisture from being drawn from sandy rootzones into fine-textured soils typically found in putting green surrounds. Moisture drawn from the edges of putting greens and collars can result in severe drought stress to turf in these areas.

Avoid unnecessary damage to the collars by minimizing hard turns with the mowing equipment on the area. Employees should be properly trained to turn their mowers in the rough beyond the collar, space permitting.

Treat the collars like the putting greens. When the putting greens are scheduled for aeration, aerate the collars as well.

TREAT COLLARS LIKE PUTTING GREENS

To as great an extent as possible, maintain the collars as you do the putting greens. When the greens are aerated, aerate the collars. Likewise with topdressing, verticutting, pest control, wetting agent use, and fertilization. Adopting this philosophy usually will thwart many turf problems common to collars, including the development of puffy turf, disease activity, reduced density, and otherwise poor playing conditions. A good cultivation program for the collars is important to maintain a smooth transition from putting green turf to collar turf.

MOWING

Mowing of collars is no different from any other portion of the golf course — lighter machines invariably result in better turf quality. Walk mowing is definitely the preferred means of maintaining collar turf. Collars can be adjusted to a 22- or 26-inch width to accommodate a single pass with common walk mowing equipment. Although there is no standard for collar width, a width that enables mowing with a single pass saves time. Many golf courses combine tee, collar, and approach mowing into one task that can be performed with the same machine. Where labor and resources are limiting, these areas may all be mowed with a triplex putting green mower. The mowing of collars almost always requires continuous turning; thus, more torque and subsequent wear injury will be imparted to the turf compared to mowing in straight lines. Consequently, triplex mowing of collars often results in turfgrass injury and inconsistent playing quality. At all costs, avoid mowing collars with fairway mowing units. To maintain good turf quality and playability, keep the fairway units off the approach and collar.

Another task to monitor when assessing collar quality is mowing of the putting greens. Turning either walk mowers or triplex mowers on the collar (especially the infamous spin turn) can accelerate wear injury and, when the turf is wet, cause direct injury. Check out the preparation of a major championship sometime and you might notice the greens mowers turning on carpet laid over the collars. Obviously, most golf courses won't go this far on daily preparation, but the method underscores the importance of protecting the collar turf. Be sure employees are properly trained to avoid causing unnecessary wear injury to the collars when mowing the greens.

Some golf courses have installed dedicated sprinklers to mist the collar area.

IRRIGATION

As mentioned above, collars are often maintained at the same height of cut as tees and approaches to streamline maintenance. Under certain conditions, this can lead to water management problems in the collars. One theory concerning accelerated turfgrass wilt in the collars versus the putting greens suggests that collar turf has an increased water demand due to the higher height of cut it receives. Therefore, reducing the height of cut during periods of drought stress may actually equilibrate water demand between the putting green turf and the collar turf. This phenomenon is usually more of a problem with new construction and seems to diffuse as the water-holding capability of the rootzone improves with time. Of course, hand watering, soil-surfactant use, and proper construction also should be considered. Also, be sure to check that accumulating sand displaced from nearby bunkers is not compromising the water-holding capacity of the rootzone.

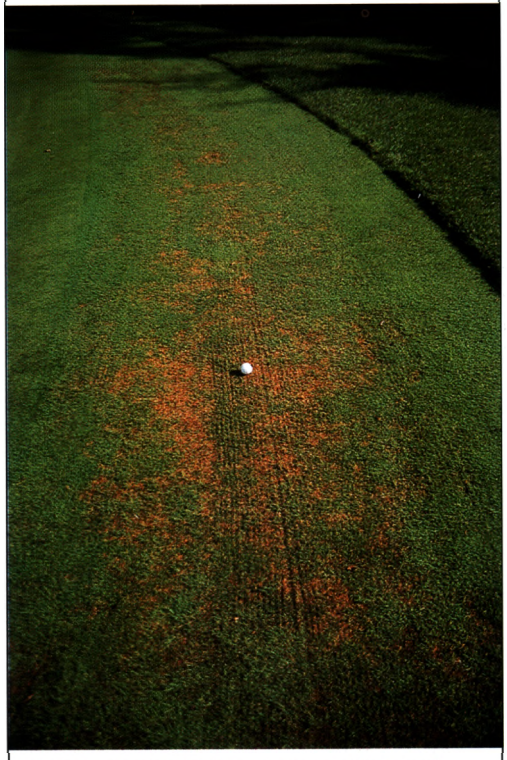
TRAFFIC CONTROL

Certain portions of the collars invariably will be subjected to concentrated traffic. It is essential that all power golf carts and pull carts be kept off of the collars. Substantial wear injury from pull-cart encroachment on collars has been observed at numerous golf courses throughout the United States where play is high and traffic control is poor. Golfers should be made aware that the relatively low height of cut and concentration of both golfer and maintenance traffic put significant stress on turfgrass in the collar.

Where design features such as bunkers concentrate golfer traffic to the extent that severe turf injury and poor playing quality exists, consult with a qualified golf course architect about potential renovations that would allow additional access areas to putting greens, whereby traffic can be more widely distributed.

CHOOSING THE RIGHT SPECIES OF TURFGRASS

In most situations, it is preferable to use the same species of grass on the collars as on the putting greens. Creeping bentgrass greens typically have creeping bentgrass collars. Likewise, bermudagrass greens generally have bermudagrass collars. But this arrangement may not be desirable or practical in some locations of the country. Kentucky bluegrass can provide an excellent collar surface in the Intermountain region of the western United States. Annual bluegrass can comprise a significant portion of the stand, particularly in coastal climates of the Pacific Northwest and elsewhere. In the transition zone, maintaining good quality creeping bentgrass collars can be a real challenge due to the myriad of stresses, including diseases, insects, physiological stress, and traffic. Where maintaining bentgrass collars is met with poor success, perennial ryegrass can be a suitable alternative. Perennial ryegrass has good traffic tolerance, can withstand relatively close mowing, and, with a reasonable disease control program, will persist. It couldn't be put any better than Stan Zontek, Director of the Green Section's Mid-Atlantic Region, says: "Ryegrass is much better than no grass"(3).



Poa annua collar turf can prove an ideal snack for certain insect pests, particularly the hyperodes weevil. Thorough scouting is necessary to properly identify the problem.

WATCH FOR SLOW TOPOGRAPHICAL CHANGES

Another common problem with long-term collar management is the slow, incremental change in grade that can occur in areas adjacent to greenside bunkers. Displaced sand from normal bunker shots accumulates on banks and collars over time. In some cases, surface drainage patterns are adversely affected and irrigation challenges arise where very droughty rootzones are created. Periodic renovation may be necessary where play from popular greenside bunkers alters drainage characteristics, management feasibility, and playability.

SUMMARY

Managing collars may require that additional cultivation, overseeding, or sod be required from time to time to provide the desired level of playing quality. This small, distinct portion of the golf course is subject to concentrated traffic and management criteria that pose stressful conditions for turfgrass. Monitoring quality control throughout construction, incorporating the putting green management program, utilizing the lightest mowers feasible, controlling traffic, and systematically troubleshooting any problems that may occur should help with your collar ID.

LITERATURE CITED

1. Beard, J. B. 2002. Turfgrass management for golf courses. 2nd ed. Ann Arbor Press, Chelsea, MI.
2. USGA Green Section Staff. 1993. USGA recommendations for a method of putting green construction. *USGA Green Section Record*. 31(2):1-3.
3. Zontek, S. 1997. Ryegrass is better than no grass. *USGA Green Section Record*. (35(3):15.

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Research *You Can Use*

Buffalograss Management Research: The Results May Surprise You

The surprising response of this native species to management inputs.

BY KEVIN W. FRANK

Buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.] is a warm-season grass native to the Great Plains region of the United States. The only turfgrass species native to North America, it has long been claimed to be a low-maintenance grass with reduced irrigation, nitrogen, and mowing requirements.

THE NEED FOR RESEARCH

In response to a 1984 USGA call for proposals to develop reduced-maintenance turfgrasses, a team of scientists from the University of Nebraska led by Drs. Edward Kinbacher, Terrance Riordan, and Robert Shearman began evaluating buffalograss for use as a turfgrass. Interest in water conservation and reducing chemical inputs for turfgrass culture made buffalograss a desirable choice. USGA-sponsored breeding efforts to improve buffalograss for use as a turfgrass have been very successful and have resulted in the release of eight buffalograss cultivars.

As the new buffalograss cultivars entered the market, it became evident that there was a need for research to investigate fundamental management practices. After all, this was not the same buffalograss that had been growing on the Great Plains for many thousands of years, but rather this was buffalograss that had been selected for favorable turfgrass traits such as color, density, uniformity, and vigor of spread.

Most management recommendations supported the low-maintenance philosophy by advocating little or no fertilizer application, as well as infrequent or no mowing. In low-maintenance areas where expectations are simply based on having ground cover, buffalograss managed in this manner is acceptable. However, for those who have planted buffalograss in golf course roughs or home lawns, following these management recommendations has often led to disappointment with the quality of turf achieved.

UNIVERSITY OF NEBRASKA RESPONDS

Common perceptions of buffalograss are that it is generally non-responsive to nitrogen applications, and high nitrogen rates do not benefit buffalograss but only increase weed interference. There also are questions about mowing height adaptation for different buffalograss cultivars. With these questions in mind, and funding from the USGA's Turfgrass and Environmental Research Program, research was initiated in 1995 to investigate nitrogen rate and mowing height effects on four different buffalograss cultivars.

Buffalograss Cultivars and Research Locations Used to Investigate Cultural Management Programs

Buffalograss Cultivars	
378	Vegetative
NE 91-118	Vegetative
Cody	Seeded
Texoka	Seeded
Research Station Locations	
University of Nebraska	Mead, NE
Kansas State University	Manhattan, KS
Utah State University	Logan, UT

Buffalograss was established in 1995, and management treatments were initiated in 1996 and continued through 1998. The mowing heights were one, two, and three inches. The one-inch height was mowed twice per week, while the two-inch and three-inch heights were mowed once per week. Nitrogen rates were applied in two equal applications, with the first application in early June and the second application in mid-July, six weeks after the first application.

A polymer coat fertilizer (36-1-6, N-P_2O_5-K_2O) was used to apply total nitrogen amounts of 0.5, 1.0, 2.0, and 4.0 pounds per 1,000 square feet. An untreated control (no fertilizer) was included as a comparison. Immediately following nitrogen application, the plots were irrigated with one-half inch of water. After adjusting for precipitation, one inch of water was applied every two weeks throughout the duration of the research. Preemergence herbicides were applied each year from 1996 to 1998 to control annual weeds.

Turfgrass quality, color, and density were rated visually on a scale of 1-9 as used by the National Turfgrass Evaluation Program (NTEP). A quality rating of 1 is extremely poor, 9 is excellent, and 6 is acceptable. Ratings were taken every two weeks, starting two weeks after the first nitrogen application, and continued until six weeks after the second nitrogen application. Clippings were harvested four weeks after each

fertilizer treatment, oven-dried, and weighed.

BUFFALOGRASS RESPONDS TO NITROGEN APPLICATIONS

The results of the nitrogen rate applications to the buffalograss revealed several interesting trends. In 1996, the first year of nitrogen treatments after establishment, there were virtually no differences in buffalograss quality, color, or density among the nitrogen rates, especially at the Kansas site. Without prior knowledge of the research, most people would not even have recognized that different nitrogen rates had been applied to the buffalograss. Perhaps results such as these led to the belief that buffalograss is unresponsive to nitrogen applications.

However, successive years of nitrogen treatments revealed otherwise. By 1998, the third year of nitrogen treatments, buffalograss was displaying a very favorable response to the nitrogen applications at all locations. As the nitrogen rate increased from 0 to 4 pounds N per 1,000 square feet per year, buffalograss quality, color, and density all increased. Although the differences in quality among nitrogen rates was very small in 1996, by 1998 the effects of the nitrogen rate had become clear. It also was evident that quality declined from 1996 to 1998 for nitrogen rates less than 2 pounds N per 1,000 square feet, remained relatively constant for the 2-pound N rate, and increased for the 4-pound N rate.

Contrary to popular notion, there was no observed increase in weed interference as the nitrogen rate increased. Buffalograss responded to the nitrogen applications just as all other turfgrasses do, with improved color, quality, and density. The lack of response to the nitrogen applications in the first year of treatments was likely due to adequate levels of soil fertility. As the residual soil nitrogen was utilized by the buffalograss over the next two years, the beneficial effects of the nitrogen applications became more evident. This may explain previous observations that buffalograss is unresponsive to nitrogen applications. If our research had been conducted for only one year, it is likely we would have drawn the same conclusion.

(Top) Buffalograss management research plots at the Kansas site at four weeks after the second fertilizer application in 1996 showing little differences in quality.

(Bottom) Buffalograss management research plots at the Nebraska site in 1998 showing marked differences in color, density, and overall quality as affected by nitrogen application rates.

BUFFALOGRASS USE ON GOLF COURSES AND LAWNS

The following recommendations are relevant to irrigated buffalograss that is mowed weekly. Buffalograss maintained in this manner is not considered to be low maintenance, but representative of common lawn management or golf course rough management practices. Expectations of buffalograss that is not irrigated or not mowed regularly would be lower and, therefore, would require different management recommendations. Although the buffalograss cultivars had the highest color, quality, and density ratings at the rate of 4 pounds N per 1,000 square feet, our recommendations are to apply 2 pounds N per 1,000 square feet per year as a split application approximately six weeks apart.

There are two reasons for making the 2-pound N rate recommendation. First,

the clipping weights at the rate of 4 pounds N per 1,000 square feet per year were significantly higher than at the other nitrogen rates. Although buffalograss had the highest quality, color, and density at the 4-pound N rate, it also had the greatest clipping production, thereby effectively eliminating any potential buffalograss has for reduced mowing frequency. Second, if we were to recommend the 4-pound N rate, we also would eliminate the reduced fertility requirement of buffalograss. Recommending a 4-pound N rate would place buffalograss under essentially the same fertilization program as other turfgrasses, such as Kentucky bluegrass.

MOWING HEIGHT RECOMMENDATIONS VARY BY CULTIVAR

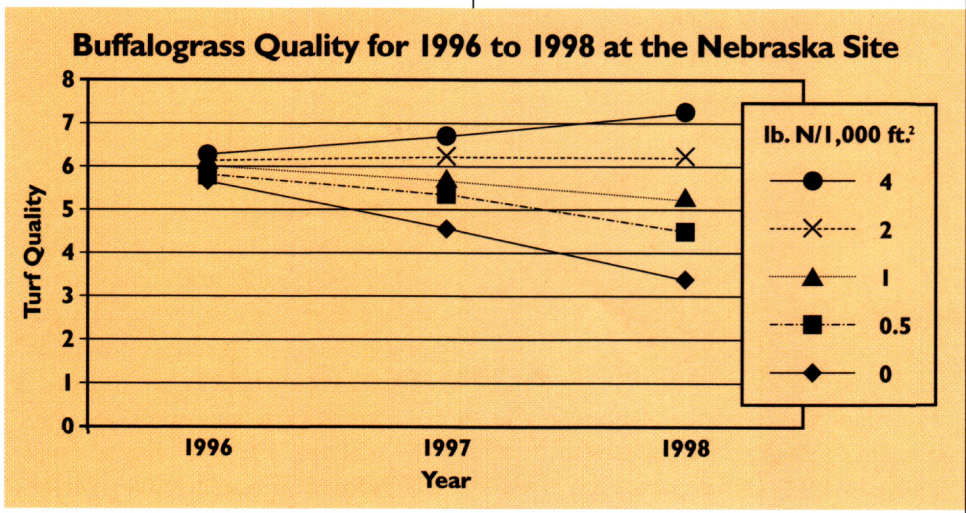
Buffalograss response to the three mowing heights varied among cultivars. At the one-inch mowing height, the vegetatively propagated cultivars 378 and NE 91-118 had good color, quality, and density. The seed-propagated cultivars, Cody and Texoka, performed poorly at the one-inch mowing height, and they rarely had acceptable density, even at the 4-pound N rate. Cody and Texoka responded well to the two-inch and three-inch mowing heights. In contrast, 378 and NE 91-118 generally had higher quality when mowed at two inches rather than three. At the three-inch mowing height, NE 91-118 often lacked uniformity. Although this appearance would be suitable for low-maintenance areas, on higher-profile areas this would be unacceptable.

Mowing height recommendations vary based on seeded or vegetative cultivars and the end-users' expectations and desired use. In a low-maintenance area, all of the buffalograss cultivars could be mowed only once or twice a year, but if a more aesthetic turf were desired, the following recommendations would pertain. For vegetative cultivars, mowing heights of one-half to three inches are acceptable. The half-inch mowing height would only be recommended for use as golf course fairways. As mentioned previously, some vegetative cultivars such as NE 91-118 have better uniformity at the two-inch mowing height. Due to poor density at low mowing heights, the mowing height recommendation for seeded cultivars is two to three inches.

MATCHING EXPECTATIONS WITH MANAGEMENT

Our research has shown that although buffalograss may still be considered a low-maintenance turfgrass, it does respond favorably to nitrogen applications and can produce a high-quality turfgrass with regular mowing and nitrogen applications. The key to successful buffalograss management is to determine your expectations and then tailor the management program to meet them. Although we recommend nitrogen applications to buffalograss to achieve a good quality turfgrass, the amount recommended, 2 pounds N per 1,000 square feet per year, is certainly less than the amount of fertilizer many turfgrasses require.

If you have buffalograss and haven't been satisfied with its performance, consider modifying your management scheme to reflect these recommendations. In the proper setting, with the proper expectations and management scheme, it may surprise you. After all, this is not the buffalograss that this nation's pioneers traveled across 200 years ago.



Buffalograss quality at the University of Nebraska site from 1996 to 1998 was rated from 1 to 9 (with 9 the highest quality and 1 the lowest quality). Quality differences did not show up until the year after fertilizer treatments began.

LITERATURE CITED

1. Beard, J. B. 1973. Turfgrass: Science and Culture. Prentice-Hall, Englewood Cliffs, NJ.
2. deShazer, S. A., T. P. Riordan, F. P. Baxendale, and R. E. Gaussoin. 1992. Buffalograss: A warm-season native grass for turf. Coop. Ext., University of Nebraska, Lincoln, NE. EC92-1245-C.
3. Harivandi, A., and L. Wu. 1995. Buffalograss — A promising drought-resistant turf for California. Coop. Ext., University of California. 45(1&2).
4. Leuthold, L., J. Pair, and R. Gaussoin. 1991. Buffalograss lawns. Coop. Ext. Service, Kansas State Univ., Manhattan, KS. Horticulture Facts MF-658 Revised.
5. Pozarnsky, T. 1983. Buffalograss: home on the range, but also a turfgrass. *Rangelands*. 5(5):214-216.
6. Riordan, T. P. 1991. Buffalograss. *Grounds Maintenance* 26(2):12-14.
7. Wenger, L. E. 1943. Buffalograss. Kans. Agric. Exp. Stn. Bull. 321.
8. Wu, L., and A. Harivandi. 1989. Buffalograss: promising, drought-resistant — and here now. *Golf Course Management* 57(4):42-54.

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A View from the Chairman

The green chairman's role in turfgrass preparation.

BY KEITH HAPP

To address golfers' questions, the green chairman should have a basic level of understanding concerning the agronomic programs used on the golf course. Action plans and maintenance goals are regularly discussed between Mark Studer, green chairman, and John Zimmers, golf course superintendent at Oakmont Country Club (PA).

The role of the green chairman has been described in many terms: challenging, frustrating, tiring, rewarding, and stimulating are just a few. However, after speaking with many Green Committee chairmen, one thing is clear. Those who volunteer to chair the Green Committee demonstrate a true love for the game of golf and their golf course. Although every course is different and maintenance budgets allocated for course preparation vary, a common goal is often expressed: improve the course to enrich golfer enjoyment.

In an effort to identify and define the role of the chairman of the Green Committee, green chairmen from four golf courses were interviewed. Two are current incumbents and two are past committee chairmen. They are:

- Mark Studer, Oakmont Country Club, Pittsburgh, Pennsylvania.
- Mack Saunders, Glen Oak Country Club, Clarks Summit, Pennsylvania.
- Ed Madenford, Conestoga Country Club, Lancaster, Pennsylvania.
- Ron Moehler, Chartiers Country Club, Pittsburgh, Pennsylvania.

A structured interview consisting of a list of ten questions was presented to each, and a summary of their answers follows.

Q Why did you want to be the chairman of the Green Committee at your course?

Saunders: I never really sought it out. It was a case of evolving into the position of green chairman. In a nutshell, I felt I could add value to the golf course, and representing the membership could add value as well.

Moehler: We had a master plan in place and there was no action being taken. I felt that I could move forward to get the renovations done according to the master plan. There were a number of people who believed we needed to act on the master plan, so that is why I did it, and we were successful in getting it through.

Madenford: I've been doing this for probably 16 to 17 years. When I was a lot younger I just wanted to make the course better, improve playing conditions, and make some architectural changes. I grew up at this club and over the years it has really changed. Years ago you just cared about the greens. Now you have to care about greens, fairways, tees, roughs, bunkers — everything. It has evolved. I've noticed the complaints from the members have changed over the years, and they are more demanding.

Q How do you define the role of the chairman of the Green Committee?

Saunders: I see the chairman of the Green Committee as essentially the *gatekeeper* of the club. The key asset is obviously the golf course. The chairman represents the golf course superintendent and the golf course requirements to the membership, the Board of Directors, and Executive Committee, and carries feedback to the golf course superintendent and the maintenance team.

The job has to be done with a fair amount of balance so that you don't end up offending someone unnecessarily. The green chairman's role is a

The USGA Turf Advisory Service visit provides an excellent opportunity to assess the long-range direction of the golf course maintenance program among the members of the Green Committee and golf course maintenance staff.

delicate balance between representing the members and representing the needs of the golf course and superintendent. In my mind, above all else, the chairman has a responsibility to build a level of trust and credibility with all the constituents in order to be truly successful.

Q How would you define the role of the chairman with regard to the maintenance of the course and its setup?

Saunders: The chairman must ensure that the superintendent is always set towards the improvement of the golf course. One of the things that we constantly say at Glen Oak, and really emphasize, is never to accept the status quo. The chairman has to work to see that appropriate funding is provided through the budgeting processes and sel the needs of the golf course to the board. After programs are funded, the chairman must work with the superintendent to ensure that the programs are completed or implemented on a timely basis. Again, this is a delicate matter because many times the full benefit of funded improvements won't show or won't come to fruition for several seasons. You've got to make sure course officials understand that the expected results won't happen overnight. However, there has to be a level of trust and confidence on the part of the board and the members that you are, in fact, going to do what you said you were going to do.

A chairman who has been around a long time and has an intimate knowledge of the golf course and putting surfaces can help with course setup, identify possible hole locations, and determine the playability of the course with the superintendent. It's also important for the superintendent and chairman to play golf together on a regular basis. The superintendent needs to see the course from a player's perspective as well as from a superintendent's perspective.

Q How are course conditioning concerns and the accompanying membership complaints addressed? Are all complaints brought to the superintendent, or are complaints filtered before they are brought to the superintendent's attention?

Madenford: We are very particular about this subject. Complaints must be put in writing, addressed to the board, and sent to me. I want

them to put it in writing, and that way I will be sure to give them a written response. The reason I do this is because I don't want to be attacked when I'm playing golf. If they put it in writing, then it is serious to them and I will answer it in writing.

Saunders: First of all, the chairman must be seen as an approachable person by the membership and at least have a level of knowledge about turfgrass and maintenance that makes him somewhat credible. You can't talk about these things without some fundamental level of knowledge to help the members understand what you're trying to do.

Secondly, while the superintendent is always available, we ask that complaints be routed to the chairman or the general manager so that the superintendent is not bombarded with unnecessary and time-consuming complaints. From that point, the chairman can take issues to the Green Committee or directly to the superintendent, depending upon the issue urgency. To close the feedback loop, the chairman has a responsibility to respond to the member who originated the complaint. In many instances the chairman can handle complaints without even involving the superintendent. Simply explaining to a member what is being done and how it will alleviate and mitigate his or her complaint is often sufficient. Finally, I see the chairman as relieving the superintendent of unneeded pressures that members unknowingly place on him.

Q How is the performance of the superintendent evaluated? Are there maintenance standards in place? Are annual conditioning goals clearly defined?

Studer: A performance evaluation is a must. The superintendent should submit his performance expectations in writing, and at that point the superintendent and green chairman jointly fine-tune the written plan and conduct mid-season and end-of-the-year written evaluations. Part of the superintendent's compensation should be tied to this review. A written job description is a must. Without one, you have *mutual mystification*. The written job description that we developed when doing the performance review is a crucial part of the contract.

Specify who does the performance evaluation. No more than two people should officially evaluate the superintendent's performance: the green chairman and possibly the club president. In business, committees do not evaluate employees; supervisors do, and the green department is a business of the club headed by the chair.

Q Is there a master plan in place (using the service of an architect) to help focus course improvements?

Saunders: We have a master, or long-range plan. It is terribly important for these plans to be dynamic and not static. I worry about developing a plan, putting it in a shiny binder on a bookshelf, and never referring to it again. We found that the needs of the course and the priority items tend to change. A plan should adapt to those changes. We don't make any changes to our golf course without a golf course architect being involved and agreeing with what we want to do.

Q How are essential agronomic programs (aeration) scheduled? For example, is aeration placed on the calendar of events and then golf is scheduled around this treatment?

Studer: The first step is to have the superintendent outline what he feels is needed and when it should be completed. This written aerification and cultivation plan should be discussed with the Golf Committee and Pro Shop staff a minimum of one year in advance. For example, our staff coordinates four agronomic procedures in early April and again in late August. The dates are published in February on the golf calendar. During the August cultivation, no guest play is allowed and players know this policy well in advance. Our part-time staff is still employed in August and, weather permitting, complete the green, tee, fairway, and approach aerification. Moving our maintenance from September to August has helped get the work completed in half the time and recovery is witnessed after only one week of disruption.

In many instances the chairman can handle complaints without even involving the superintendent. Simply explaining to a member what is being done and how it will alleviate and mitigate his or her complaint is often sufficient.

Communication is the key. New technologies help us show the committee, board, and members what is happening to their turfgrass. We use a digital camera, laptop, and LCD projector to show pictures of before and after work. Weather permitting, part of each committee meeting is conducted on the golf course to see firsthand what progress is being made.

Madenford: First, every year I give our golf professional an aerification schedule. We aerify one week in the spring and a small aerification in the fall. It's on the calendar and scheduled by January 1. They run their golf around us . . . you have to be proactive or the golf program will take over. If we put our schedule out there first, it supersedes golf events.

Q What role does the chairman have regarding communications between Pro Shop and superintendent, Golf Committee and superintendent, and the membership and superintendent? Do you act as a facilitator?

Saunders: The green chairman acts as a major facilitator with all of those constituencies, and the chairman has to use a variety of communication methods. For example, we developed a column in our club newsletter entitled "For the Good of the Game." This newsletter includes an article on golf course activities, respect for the golf course, and the whys of various programs that are underway. In some cases, I feature information that we received from the Turf Advisory Service visits. It informs members of the things that we need to be doing or specific activities that we are doing well.

Last year we conducted an open Q&A session for all of our members. The focus was installation of the new irrigation system. We explained why we were spending $1.1 million and the benefits that could be expected. It's very important for the chairman to have this communication throughout the club.

Studer: Communication is the key. New technologies help us show the committee, board, and members what is happening to their turfgrass. We use a digital camera, laptop, and LCD projector to show pictures of before and after work. Every committee meeting includes a PowerPoint presentation showing the latest aerification methods or irrigation repairs. Weather permitting, part of each committee meeting is conducted on the golf course to see firsthand what progress is being made.

We recently installed a new irrigation system and had a map of the course in the lobby and at our indoor practice facility. Members could follow the progress as the staff color-coded the map as to what had been completed. For us, the opening golf meeting and dinner is the perfect opportunity to present a 20-minute PowerPoint presentation of our four spring aerification procedures. Questions are fielded and all members learn how crucial this cultivation is for the continued health and playability of our turf. As the saying goes, a picture is worth a thousand words.

Q How is course closure handled? Does the superintendent have the authority to make this decision? If not, who has the final say?

Studer: It is your superintendent's call! If you micro-manage these decisions, you undermine the long-term goals of managing the turfgrass. Listen to your turfgrass professional and trust his decision-making. This is the green chairman's best opportunity to reinforce the team concept of turfgrass maintenance by allowing the staff to stick to their action plan.

Why is this so important? When obstacles have been removed for the superintendent to do his job, you can now, in all fairness, hold him accountable for the turfgrass health and playability. For example, if you micro-manage aerification schedules and course closings, you perhaps have given the superintendent a legitimate reason for subsequent turf problems. This would not be good for the club or the superintendent. Let the staff do their job.

Other maintenance decisions the green chairman should endorse and help clearly define are:

How long should play be suspended for frost?

When can I use my cart today?

Do we have to play temporary greens?

When will the course reopen after the storm?

Saunders: I would simply say the superintendent has *total* control and responsibility for the golf course. He is told and encouraged to make whatever decision is appropriate. The chairman, in my mind, sets the tone and creates the environment in which the superintendent feels comfortable to make a responsible decision, not one that is expedient or political just because some members want the course open when it should not be. The overall golden rule that we use is, we will never put our golf course at risk.

Q How is the operating budget developed, and how are monies allocated for capital improvements to the course and equipment purchases?

Studer: You cannot approve a fair grounds budget before specific, written course-conditioning standards are determined. For example, the Green Committee and superintendent decide the frequency and height of cut for greens, tees, fairways, and rough. The next step is to evaluate what additional items cost, like one or two additional fairway mowings. Is it worth it and do members expect it? Our club has compared our operating budget to other clubs that have similar conditioning expectations. Our local golf association conducts an annual green department questionnaire and publishes the results. This has developed into an excellent starting point for reviewing expectations and budgets.

Capital budgets can blindside the committee if they are not openly discussed and appropriately justified. We have a revolving 10-year budget based on a complete written equipment inventory with the remaining useful years of every piece of equipment listed. The staff prioritizes the replacement schedule.

Saunders: We adopted a sequential process. First, we analyze where we are in the current fiscal year in terms of expenses. Second, we know that our club increases dues annually in the area of three to five percent. We simply take between three and five percent increase of the existing year's budget to get a ballpark number for the following fiscal year. Specific needs are taken into account as we project the upcoming budget cycle. Finally, the superintendent and the chairman work jointly to prepare a formal budget document. All the rationales used to develop each individual line of the budget are included in the final document.

In terms of capital, the superintendent prepares a list of capital requirements for projects and equipment replacement, including supporting rationale and cost estimates. I, separately, prepare a similar list from my perspective and then we meet jointly to discuss and prepare one final, prioritized list for the next year. The overall guide that I have learned to use is that I know at my club if I present a good case I can get about $100,000 for capital projects or equipment replacement for the following year.

The buck stops here. The final decision on the care of the golf course should be made by the golf course superintenent.

CONCLUSION

The Green Committee serves a vital role in the preparation of the course, and the chairman of the Committee is the link that connects the circuit between membership/golfer, other functions of the club and the superintendent. The chairman is a facilitator who supports and guides the superintendent to help achieve conditioning desired by the players. Nothing can be more satisfying than receiving praise for course conditioning and playability. This can happen when clear and obtainable goals are put forth.

The United States Golf Association Green Section offers a publication entitled *A Guide for Green Committee Members* (USGA Order Department, 800-336-4446). Many commonly asked questions regarding the function of the Green Committee and the chairman are answered in this booklet. Contact your local Green Section office for further information and/or assistance.

KEITH A. HAPP *is an agronomist in the USGA Green Section Mid-Atlantic Region.*

A Neighbor Says Your Chemicals Make Him Sick . . . What to Do?

You can be prepared for the toxic tort.

BY J. MICHAEL VERON

You're sitting in your office one Wednesday morning, wondering what to tell the golfers at your course who complain that their tees aren't level and who gripe that the rough is too high. The phone rings. It's a homeowner who lives next to the fourth hole. He says that he's having severe headaches and can't sleep at night, all because of the chemicals you're using on the golf course. He then says he's consulted a lawyer and intends to sue the club if you don't stop what you're doing.

Suddenly, the complaints about the tees and the rough don't seem like such a big deal anymore. What are you going to do?

You've just been presented with what lawyers refer to as a *toxic tort* claim, which means a claim made by someone who alleges he was injured by exposure to a poison (*i.e.*, toxin). As a trial lawyer who spent a number of years defending toxic tort cases, I can tell you that your first line of defense is to separate fact from fiction and to eliminate the hysteria that often accompanies such claims.

Anyone who reads the newspapers or watches the television news knows all too well that the world is full of fear-filled people who overreact to things they do not understand. This is particularly true in these kinds of cases. In one prominent case, the news media reported that a chemical plant had experienced an accidental release. Area hospitals began to fill with persons reporting symptoms from exposure to the released chemical. It was then discovered that the news report was false and that no release had occurred. Yet many of these people insisted to their doctors that they had been poisoned.

For this reason, it is important to document whether the person claiming to be injured is really sick and, if so, what is the real cause of his or her illness. Determining whether the person is really sick is a matter of gathering his or her medical records. Determining whether your chemicals were the cause of any illness is a matter of verifying whether the chemicals you used can actually cause the individual's symptoms.

Fortunately, you don't have to do this by yourself. Your first step, of course, is to report the homeowner's complaint to management, who presumably will notify your general liability insurer. The claims adjusters at the insurance company will retain attorneys and other professionals, including medical experts, to investigate and evaluate the claim, and they will gather the medical information that is needed.

For your part, you can do your very best to document to the greatest detail possible what chemicals you have used during the relevant time frame. Dose is everything in toxic tort cases, so the amount of chemical you used is very important. You are certain to be asked for this information by your insurer or its lawyers and experts, as it is their — and your — best line of defense. Maintaining complete pesticide records and having this information at hand will be most helpful to resolving any toxic tort claim on the basis of the facts rather than emotion.

J. MICHAEL VERON *is a trial lawyer based in Lake Charles, Louisiana. He also volunteers as a member of the USGA Sectional Affairs Committee.*

Research *You Can Use*

Getting to the Root of Summer Bentgrass Decline

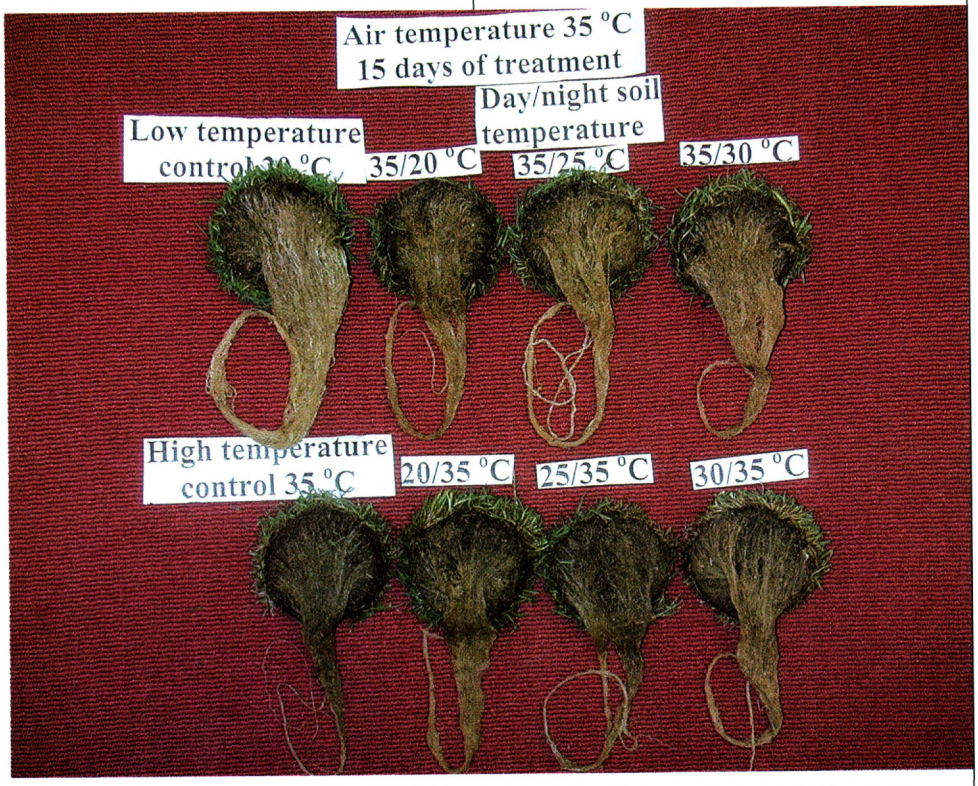
How summer heat affects creeping bentgrass roots.

BY BINGRU HUANG

Thinning of turf canopy, yellowing of leaves, and death of roots are often observed on creeping bentgrass greens during midsummer in many areas of the country. Dieback of creeping bentgrass on putting greens has been referred to as summer bentgrass decline (SBD). The cause of summer bentgrass decline has been attributed to numerous factors, including high temperature, excessive or deficit soil moisture, poor soil aeration, and high relative humidity.

HIGH SOIL TEMPERATURES

High temperature is found to be the primary factor leading to SBD. Specifically, high soil temperature is more detrimental than high air temperature in causing SBD. This decline is particularly a problem on greens with poorly aerated soils due to poor drainage and/or compaction. It also is a problem on sites with reduced evapotranspirational cooling due to poor air circulation and high humidity. These factors all contribute to soil heat retention, and thus higher soil temperatures at night.



Research investigates the impact of different soil temperatures on the growth of creeping bentgrass roots. Results indicate that lowering soil temperature can alleviate heat stress injury in creeping bentgrass when air temperature is high.

Although little can be done to modify the air temperature, one approach to prevent summer heat injury in creeping bentgrass when air temperature is high is to reduce soil temperature using proper cultural practices. Our studies have shown that lowering soil temperature can prevent or alleviate heat stress injury in creeping bentgrass when air temperature is high.

In previous experiments, reducing soil temperature by only 5°F (from 95°F to 90°F) constantly for 24 hours a day improved creeping bentgrass turf quality, and shoot and root growth when air temperature was maintained at 95°F. Root and shoot growth improvements were greater as soil temperatures were further reduced toward optimum soil temperature. However, continuous soil temperature reduction for 24 hours a day can be costly, and reducing soil temperature during the day when play takes place may not be practical.

Soil temperature is controlled by radiation, convection, or conduction. Radiation is the major contributor to increasing soil temperatures. Reducing soil temperature during the night may be easier and more economically feasible than during the day, because nighttime soil temperature is no longer affected by radiation.

Furthermore, lowering nighttime temperature may reduce carbohydrate consumption and increase carbohydrate

availability by suppressing dark respiration. Respiration uses stored carbohydrates to supply metabolic energy. Dark respiration is sensitive to temperature changes and decreases with lowering temperatures. Carbohydrate availability decreases during the night because all plant parts go through dark respiration, and there is no photosynthesis and carbohydrate production. During the daytime, photosynthesis prevails and results in carbohydrate accumulation.

GROWTH CHAMBER STUDIES

Experiments were conducted to examine whether bentgrass growth could be improved by lowering soil temperature for 12 hours a day and whether nighttime temperature reduction is more effective in improving bentgrass growth and quality than reducing daytime temperature. Creeping bentgrass (Penncross) was grown in growth chambers under three different day/nighttime soil temperature regimes.

To capture, record, and analyze root images, a video camera is mounted in a tube and inserted into plexiglass tubes buried in field research plots.

The bentgrass was exposed to three treatments:

- Air temperature maintained at 95°F for 24 hours per day (heat stress).
- Soil temperature maintained at 70°F and 77°F for 12 hours during the dark period (nighttime) and at 95°F for 12 hours during the daytime.
- Soil temperatures maintained at 70°F and 77°F for 12 hours during daytime and at 95°F for 12 hours at nighttime.

Reducing soil temperature to 70°F or 77°F for 12 hours during either daytime or nighttime for two weeks following heat stress was sufficient to maintain turf quality above the acceptable level and to increase shoot vertical extension rate and leaf chlorophyll content. Plants exposed to reduced nighttime temperatures had a higher turf quality, shoot growth rate, leaf chlorophyll content, and a more extensive root system than those with reduced daytime temperatures at 70°F and 77°F.

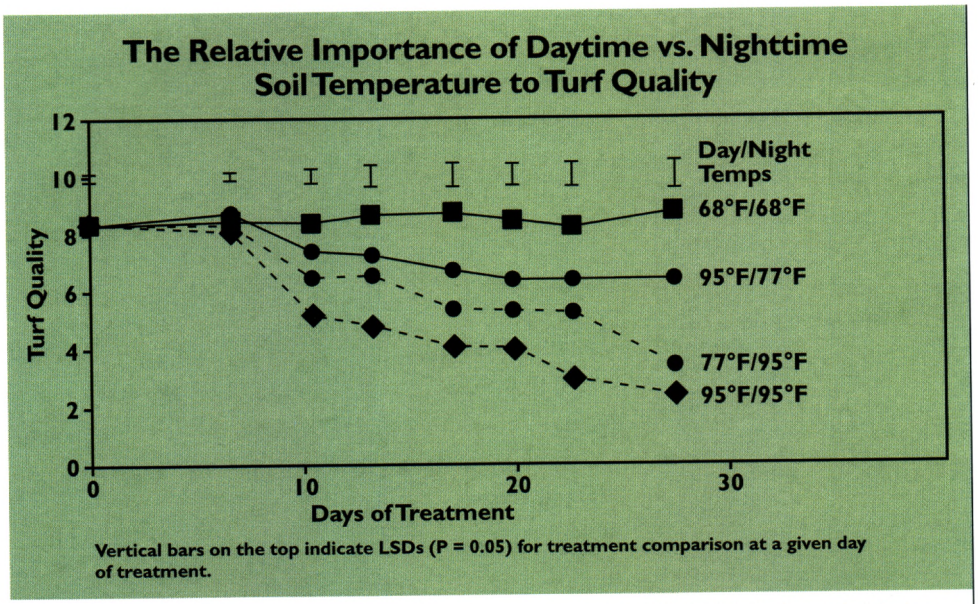
Plants exposed to reduced nighttime temperatures had approximately 45% greater root weight than those exposed to reduced daytime temperatures at 70°F and 77°F. Root growth may be affected by the alteration of carbohydrate distribution patterns in roots and shoots due to changes in daytime or nighttime soil temperatures. Lowering soil temperature during the night increased root carbohydrate content in proportion to that in shoots.

REDUCING SOIL TEMPERATURES IN THE FIELD

Generally, lowering soil temperature on shoot and root growth was more effective at the lower temperature (70°F) than higher temperature (77°F) and during nighttime than during daytime. Therefore, soil temperature should be reduced to as low a level as possible and should be practiced at night, if possible, to achieve better plant growth and turf quality in the summer.

Various methods, including fans, syringing, and subsurface cooling systems, have been recommended to reduce soil and canopy temperature (1, 4, 7). Some superintendents use fans from early morning to the evening. Others run fans only during the early morning to mid-morning when dew and surface moisture are greatest. A decrease in canopy temperatures (4° to 10°F) during peak periods of sunshine and air temperature (11 a.m. to 2 p.m.) and a decrease in soil temperature at the 4" depth of 2° to 6°F has been reported due to the use of fans (6).

A subsurface cooling system is a unit that either blows air into a green through existing drain lines or pulls out excess water from the green. Soil temperature can be increased or decreased using this system, depending on the direction of air movement and the time of the system in operation. Dodd et al. (4) reported that pulling air through the green for several hours during the evening decreased the temperature by 3° to 4°F at a 2" soil depth; air injection through the green during a sunny day actually increased soil temperature by 3°F because of the high air temperature on a hot day. Bigelow et al. (3), however, found that air injection or water



In growth chamber experiments at Rutgers University, researchers established that elevated nighttime temperatures are more deleterious to Penncross creeping bentgrass turf quality than elevated daytime temperatures.

pulling through the greens for a short time period (5 minutes) using the subsurface system had no effect on soil temperature. Therefore, when soil cooling practices are implemented, the duration should be considered.

Achieving a large magnitude of soil temperature reduction through routine management practices generally can be difficult. Injecting cool air through the green or pulling excessive warm water out followed by irrigation with underground, cool water, or syringing with cool water in combination with fans may be better in lowering soil and turf canopy temperatures. Other techniques that can reduce soil temperature under golf greens need to be explored.

In summary, our research results suggest 12-hour soil cooling was adequate to improve turf quality and root growth. However, the effectiveness increases with the duration of soil cooling. If there is a choice of nighttime vs. daytime cooling, nighttime cooling was more effective than daytime cooling in alleviating heat injury. A greater level of soil temperature reduction may be needed to achieve effective enhancement in turf and root growth in cases where soil cooling can only be practiced during the day.

LITERATURE CITED

1. Beard, J. B. 1998. Heat stress causes and prevention. *TurfNews* 6:1-6.
2. Beard, J. B., and W. H. Daniel. 1965. Effect of temperature and cutting on the growth of creeping bentgrass (*Agrostis palustris* Huds.) roots. *Agron. J.* 57:249-250.
3. Bigelow, C. A., D. C. Bowman, D. K. Cassel, and T. W. Rufty, Jr. 2001. Creeping bentgrass response to inorganic soil amendments and mechanically induced subsurface drainage and aeration. *Crop Sci.* 41:797-805.
4. Dodd, R., B. Martin, and J. Camberato. 1999. Subsurface cooling and aeration. *Golf Course Management* 67(9):71-74.
5. Huang, B., X. Liu, and J. D. Fry. 1998. Shoot physiological responses of two bentgrass cultivars to high temperature and poor soil aeration. *Crop Sci.* 38:1219-1224.
6. Taylor, G. R. 1994. The effects of mechanically induced air movement on the temperature, leaf water potential, and soil moisture percentage of creeping bentgrass (*Agrostis stolonifera* L.) golf greens [M.S. thesis]. North Carolina State University, Raleigh, N.C.
7. Trusty, S., and S. Trusty. 1998. Hot town cool bentgrass. *Golf Course Management* 66(4): 186-191.
8. Xu, Q., and B. Huang. 2000a. Growth and physiological responses of creeping bentgrass to changes in air and soil temperatures. *Crop Sci.* 40:1363-1368.
9. Xu, Q., and B. Huang. 2000b. Effects of differential air and soil temperature on carbohydrate metabolism in creeping bentgrass. *Crop Sci.* 40:1363-1368.
10. Xu, Q., and B. Huang. 2001. Lowering soil temperatures improves creeping bentgrass growth under heat stress. *Crop Sci.* 41: 1878-1883.

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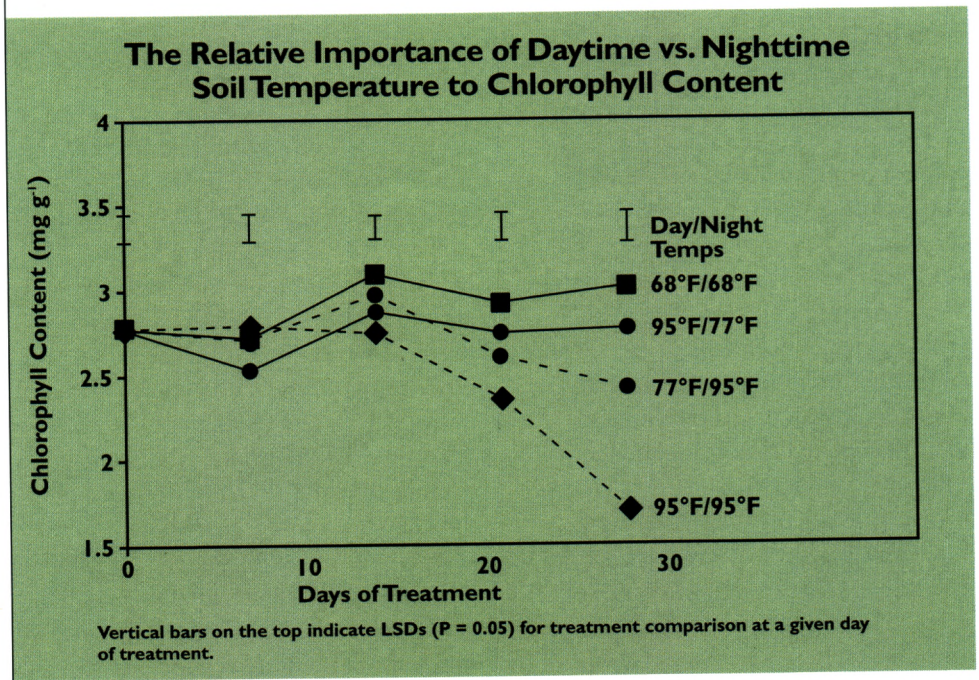


Elevated nighttime temperatures resulted in much more rapid loss of chlorophyll in Penncross creeping bentgrass compared to elevated daytime temperatures.

Proper Etiquette

A little effort can make all the difference.

BY PAUL VERMEULEN

As the tools for maintaining putting greens have improved over the past decade, superintendents have gained the upper hand in the daily battles against fungal pathogens, unwanted weeds, and nuisance pests. While victory is always cause for celebration, the war against bumpy putting conditions has yet to be declared over.

Many greens still look like battlefields despite the advances of modern technology because they are pitted by hundreds, and in some cases thousands, of unrepaired ball marks. Proper etiquette demands that each golfer repair his/her own ball mark before walking off the green. So why, then, do so many choose to ignore the damage caused by their own hand?

The damage caused by unrepaired ball marks is no small matter. These blemishes literally constitute the number-one problem facing many superintendents during the peak of the golfing season when 200 or more rounds are played each day.

The solution to this problem cannot be found in the application of sound agronomic practices. Superintendents cannot simply apply more fertilizer, as this would compromise the overall health of the turf and reduce the putting quality of the greens. Where, then, can we turn for answers?

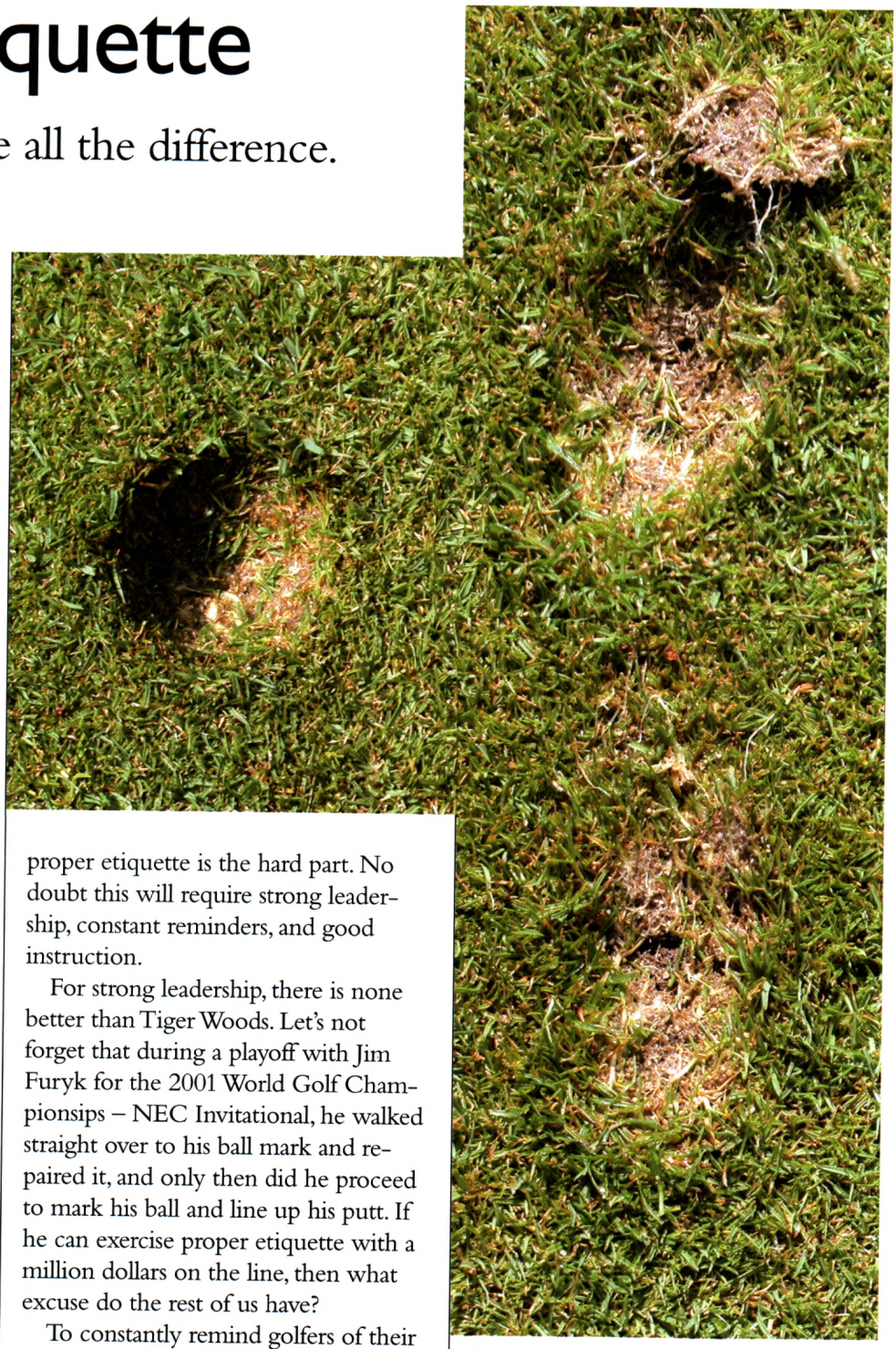
Truthfully, the answer lies at the feet of golfers. This is because ball marks must be repaired almost immediately in order for them to heal properly. When left unattended, the injured turf is subject to desiccation under the strong summer rays of the sun, and death of some grass can be expected within hours.

Identifying the guilty parties is the easy part. Getting them to follow proper etiquette is the hard part. No doubt this will require strong leadership, constant reminders, and good instruction.

For strong leadership, there is none better than Tiger Woods. Let's not forget that during a playoff with Jim Furyk for the 2001 World Golf Championsips – NEC Invitational, he walked straight over to his ball mark and repaired it, and only then did he proceed to mark his ball and line up his putt. If he can exercise proper etiquette with a million dollars on the line, then what excuse do the rest of us have?

To constantly remind golfers of their duties, the weight of responsibility must fall on two of the game's professional organizations, the PGA of America and the GCSAA. Each course should have at least one member from each organization to remind golfers before and during each round.

Solving the ball mark problem should be a quick fix. Remember, a little effort can make all the difference.



Ball marks come in all different shapes and sizes. The end result is still the same — they need to be repaired in a timely manner to minimize long-term damage to the putting surface.

PAUL VERMEULEN *is the director of the USGA Green Section Mid-Continent Region. An avid weekend golfer, he never fails to repair his own ball mark plus one or two others left by those who do not follow proper etiquette.*

Saving the Small Sundrop

Making an opportunity out of an obstacle.

BY MARY LONGYHORE, MARK PETITGOUE, AND TOM MORGENSEN

PHOTO ©KIM KARPELES/WWW.KIMKARPELES.COM

For many developers, the discovery of an endangered or threatened species on site is the last thing one hopes to encounter during construction. Thoughts of abruptly halting a project or of expensive mitigation measures can easily override goodwill toward the environment. Yet when ThunderHawk Golf Club discovered more than 2,000 small sundrops (*Oenothera perennis*), a state-threatened plant species, during construction, the project's developer, Lake County Forest Preserve, took it as an opportunity to save Illinois' largest known population of this native flower.

Opened for play in 1999, ThunderHawk Golf Club in Beach Park, Illinois, is set on 243 acres of rolling terrain and features more than 32 acres of wetlands (15 restored and 17 created), 74 acres of woodland (17 of which were created with new or transplanted trees), and more than 57 native prairie acres. As a member of the Audubon Signature Program, ThunderHawk Golf Club committed to the highest level of environmental stewardship, starting in the design and development phase of the project. Central to its management approach is providing top-quality playing conditions while adhering to practices that conserve wildlife, enhance habitats, conserve water and energy, and minimize chemical use.

When the small sundrop was first discovered, we called upon a number of professionals on staff who could quickly address issues of threatened species protection. This enabled us to develop and implement a conservation plan while resuming construction. Following recommendations from the Illinois Division of Natural Resources and with assistance

from Audubon International, we took steps to ensure that the population of this species would continue to thrive for future generations to enjoy.

THE RIGHT COMBINATION: PROTECTION ZONES, MANAGEMENT PLANNING, AND EDUCATION

Our first defense to ensure long-term survivability of the sundrop was to transplant more than 300 plants from construction areas into zoned protection areas. The goal of the *protection zone* is to safeguard and expand the population of the small sundrop and sustain its habitat, while allowing for proper maintenance of the golf course.

Next, we instituted a natural area management and monitoring plan that includes prescribed burning, exotic species removal, and other natural resource management measures. For instance, mowing, pesticide, and fertilizer use are modified or eliminated in buffer zones around protected areas. A 20-year monitoring program also has been started.

Equally important, we began a public awareness and education campaign, using informational publications, text on scorecards, photos in the clubhouse and throughout the course, and signs around protection zones. These measures provide information not only about the sundrop, but also about the site's natural resources.

Golfer awareness and interest have been overwhelming. Golfers are excited to learn about the small sundrop and readily ask questions about the plant after reading information provided on site. They often look for the sundrop while playing.

PROTECTION EFFORTS TRIPLE SMALL SUNDROP POPULATION

Our efforts are paying off. Overall, the population of small sundrops has tripled since construction started in 1997. Our monitoring process has shown that the entire population seems to be stable throughout the protection zones. The annual cost of monitoring the small sundrop at ThunderHawk has been around $1,500. And, while no economic savings are anticipated, the intangible savings in terms of ecological value and golfer satisfaction are well worth it.

Opened in 1999, the ThunderHawk Golf Club achieved designation as a certified Audubon Signature Sanctuary in May 2001. ThunderHawk Golf Club's marketing coordinator MARY LONGYHORE, *golf course superintendent* MARK PETITGOUE, *and superintendent for the Lake County Forest Preserve* TOM MORGENSEN *collaborated with Jean Mackay, director of educational services for Audubon International, to produce this article. Address inquiries to Mary Longyhore at mlongyhore@co.lake.il.us or Mark Petitgoue at mepetitg@wans.net.*

Just The Facts, Ma'am, Just The Facts

Searching for the truth about pesticides and their impact on the environment.

BY BRIAN MALOY

Studies associating pesticides with cancer led radio commentator Paul Harvey to speculate that pesticides applied to golf courses "might be killing people." How is that for an attention grabber?

Unfortunately, a number of well-intentioned environmentalists will conjure up vivid, emotional images. In many instances, facts are blown out of proportion in an effort to solicit support and attention for their cause. Making matters worse, it seems that some media representatives are more interested in getting their next hot story than dispensing a realistic risk analysis.

In the United States today, it has become a considerable challenge for people to decipher fact from fiction with regard to pesticides and the environment. There is a tremendous misunderstanding in our society about pesticides. Facts are boring, while telling emotional stories and fallacies peaks television ratings. It is human nature to be intrigued and curious about the abnormal or unusual.

For example, picture in your mind little 5-year-old Billy playing in his backyard. He decides to crawl under the fence that separates his parents' yard from the neighboring nuclear power plant facility. Billy jumps into an unsupervised large vat of dihydrous-oxide. Fear creeps into your mind as you begin to worry about Billy's outcome.

Later, a television news team discovers Billy as his mom pulls him from the vat of dihydrous-oxide. His fingers and toes are wrinkled and his skin is red. It's a touching sight as the mother is reunited with her lost child. Shortly thereafter, a spokesperson from the power plant shows up for questioning. The reporter fires, "How could you let poor little Billy gain access to that chemical vat?"

The spokesperson responds, "We had the perimeter surrounded with an eight-foot fence and a sign that says, 'No Trespassing'!"

The reporter replies, "You know that 5-year-olds can't read. Well, what was the chemical in the vat, anyway?"

The spokesperson answers, "Dihydrous-oxide, or more commonly referred to as water."

Perhaps you were expecting to read next that Billy had chemical burns covering 90 percent of his body.

I know, you feel let down; the story lost its luster once the facts on the subject were made available. Similarly, the story is not nearly as exciting when pesticides are used according to their label directions. Did you know the EPA requires hundreds of toxicological studies, and that millions of dollars are spent with independent researchers, and that it takes ten years or more before a pesticide can be granted registration for use in the marketplace? I guess some people feel that's still not enough to ensure our safety. I wonder if any of those well-intentioned individuals have calculated what the consequences or damages would be if pest outbreaks were not curtailed in crops. Would there be enough food to feed the world? Or, how many people would die from allergic reactions from fire ant bites if there were no control? Using pesticides responsibly protects golfers from mosquitoes and the ticks that carry Lyme disease. Pesticides also reduce pollen levels and subsequent allergies. It is a mistake to assume that because pesticides kill certain pests, they are necessarily a threat to non-target wildlife or humans.

In searching for good scientific information, the USGA Green Section has spent more than $21 million since 1983 directed towards turfgrass research. A large percentage of those funds have been appropriated towards answering questions concerning pesticides and their impact on the surrounding environment.

For more information pertaining to pesticides and their impact on the environment, visit the USGA Website at www.usga.org/green for details on unbiased, independent university research. Hopefully, more people will do their own detective work to separate fact from fiction concerning pesticides and their impact on the environment. As Joe Friday from *Dragnet* so often put it, "Just the facts, ma'am, just the facts!"

BRIAN MALOY *was an agronomist for the USGA Green Section in the Mid-Continent Region from 1996 to 2002. He now puts his skills to the test as the new superintendent of Coldwater Creek Golf Links in his home town of Ames, Iowa.*

UPDATED AUDUBON STEWARDSHIP GUIDE NOW AVAILABLE

The 2002 edition of *A Guide to Environmental Stewardship on the Golf Course* is now available from Audubon International. The guidebook is designed to help superintendents and others interested in environmental management to blend environmentally responsible practices into the day-to-day operations of golf course management.

The book incorporates knowledge gained through Audubon International's ten years of work to help golf courses serve as ecologically valuable green spaces throughout North America, while reducing potential environmental impacts associated with golf course operations. The 128-page *Guide* covers a variety of topics, including environmental planning, wildlife and habitat management, chemical use reduction and safety, water conservation and water quality management, and how to build support through outreach and education activities. Project plans, case examples, and plenty of reference material are included to help golf courses achieve their environmental goals.

To order a copy of *A Guide to Environmental Stewardship on the Golf Course*, contact Jennifer Batza, Audubon International membership secretary, at (518) 767-9051, extension 12, or e-mail jbatza@audubonintl.org. The guide can also be ordered from Audubon International's online store at www.audubonintl.org/store. Cost: $25.00. Note: New members of the ACSP for Golf Courses will receive the *Guide* as part of their new member packets.

NEW CONSTRUCTION PUBLICATION AVAILABLE

Building the USGA Green: Tips for Success by the USGA Green Section staff is now available. This booklet addresses the practical side of building greens according to the USGA Guidelines. While the Guidelines address the specific details of the method, they don't, for example, describe the best procedure for digging the cavity, installing the drainage system, or adding the gravel and rootzone mixtures to the profile.

The *Tips for Success* booklet is based on input from experienced agronomists, architects, builders, and golf course superintendents. In addition to addressing the practical side of construction, it includes suggestions for planting and grow-in, and provides additional information and reading references.

Building the USGA Green: Tips for Success (publication #PG1112) is available for $4.50, plus shipping and handling, through the USGA Order Department at 800-336-4446 or www.usgapubs.com.

REGIONAL OFFICE OPENED

The southern half of the Mid-Continent Region has opened up a new office location. Bud White, agronomist, can be reached at:

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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.

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FAX: (218) 773-3151
E-Mail: lab@dakotapeat.com

European Turfgrass Laboratories Ltd.
Unit 58, Stirling Enterprise Park
Stirling FK7 7RP Scotland
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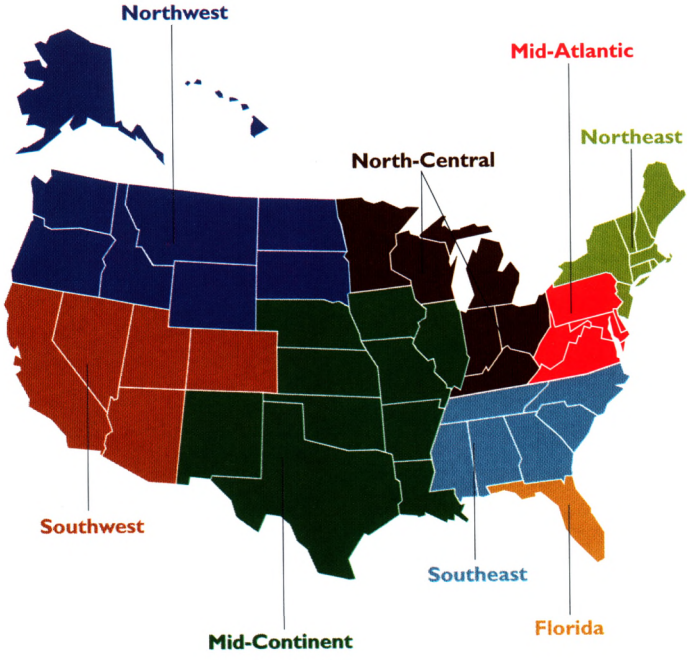

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Turf *Twisters*

Q: We get dark green dots on our putting greens for several weeks after core aeration. What causes this condition and what can we do about it? (Nevada)

A: The green dots are usually a sign that you have excessive thatch and organic matter accumulation at the surface of your greens. Air and water movement through the aeration holes is better compared to the surrounding areas, producing darker, healthier turf over the aeration holes. Consider

accelerating the rate and frequency of aeration and topdressing over the next year to amend the surface. Also, be sure to fill the aeration holes completely to the surface with sand topdressing to obtain the maximum benefit from your aeration treatments and keep the aeration channels open to the surface.

Q: We are experiencing problems maintaining a grass cover on our driving range tee surface. How large does my driving range tee need to be? (Colorado)

A: Two pieces of information are needed to answer the question of whether a practice or driving range tee is large enough: 1) Is a routine divot repair and golfer rotation program being followed to ensure timely regrowth of teeing surfaces following golfer use? 2) Is the teeing ground large enough to allow adequate regrowth for a dense grass teeing surface when the rotation returns to the reseeded areas? If you do not have a routine divot repair and golfer rotation program in place, implement one for at least one full season to see if the tee size is adequate. If you do have a routine divot and golfer rotation in place and still are not able to keep grass cover on the tee surface, then your tee is too small. Two options are available for gaining additional teeing area. One option is to replace a row of grass with concrete and artificial turf to allow rotation between the grass and artificial surfaces. A second option, provided adequate space is available on site, is to expand the teeing surface area by new construction.

Q: I continue to hear more discussions about nematodes and the negative impacts that they may cause on cool-season grasses in more northern climates. I know that nematodes are a significant problem in the South, but how prevalent is the problem further north?

A: Opinions vary. More research is being done to determine the impacts of nematodes on cool-season grasses in the North. There is still a lot to learn. If you believe that nematodes are causing a problem at your course, be sure to send samples from suspicious areas prior to the onset of any symptoms. This will allow baselines to be established for the various nematode species, and will provide a point of comparison for future tests.

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