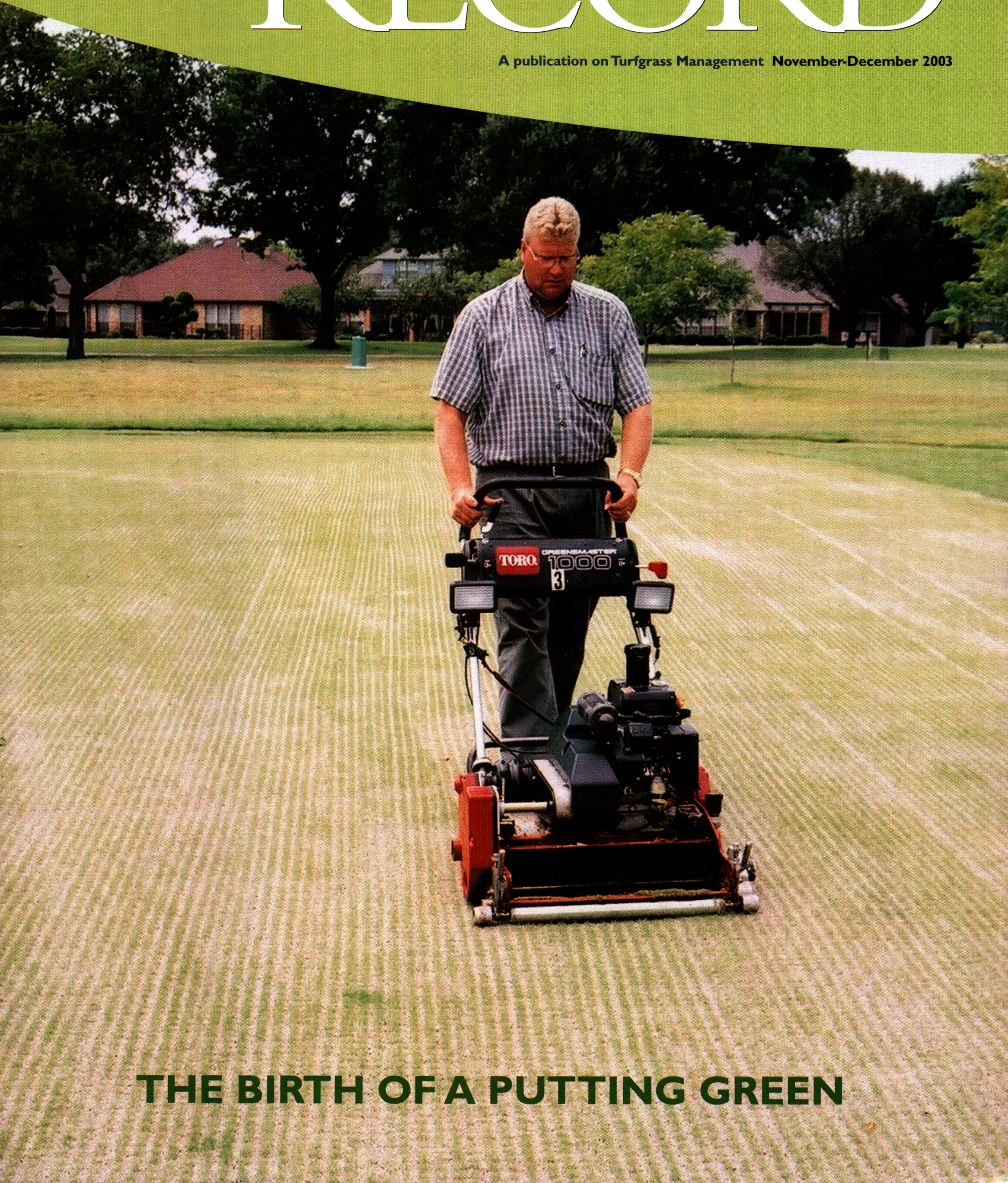
USGA GREEN SECTION

RECORD

A publication on Turfgrass Management November-December 2003



THE BIRTH OF A PUTTING GREEN

Contents

November-December 2003 Volume 41, Number 6

23

7

9

USGA President
Reed Mackenzie

Green Section Committee Chairman
Bruce C. Richards
12202 NE 31st Place
Bellevue, WA 98005

Executive Director
David B. Fay

Editor
James T. Snow

Associate Editor
Kimberly S. Erusha, Ph.D.

Director of Communications
Marty Parkes

Cover Photo
Careful monitoring of the long and arduous process of growing-in a new putting green helps avoid problems along the way.

THE BIRTH OF A PUTTING GREEN

A turf manager's guide for establishing a new putting green.

BY CHARLES B. (BUD) WHITE

The decision as to when the first mowing should occur is based on vertical growth, not turfgrass density. This bentgrass (left) is ready for the first cut 17 days after seeding. The Tifdwarf bermudagrass green (right) is ready to be mowed 18 days after sprigging.

The green complex sod is laid. Pre-plants are applied. The putting surfaces are floated out, ready for planting. The club has invested hundreds of thousands of dollars in this project and you have the responsibility of getting the green complexes ready for play. The contractor is finished and now they're *yours* and you have little or no grow-in experience. Are you ready as the turf manager?

Growing in new greens is probably the most underestimated challenge in golf turf management. This is because superintendents rarely have the opportunity to establish a new green and, consequently, are not well versed on the subject. To bridge this gap, the key areas of a successful grow-in are presented in this article as a reference. When appropriate, this article also can serve as an educational tool to help golfers, course owners, and real estate developers appreciate the scope of work involved in establishing new greens.

A poor grow-in can have devastating consequences to both the short- and long-term success of a project for several reasons. The more familiar aspects of growing in new greens involve soil fertility and disease suppression; however, there are many other facets that are equally important and are often overlooked or misunderstood. These might include how to compact the rootzone, when and how to reduce daily irrigation, when to mow the turf for the first time, and how to manage the grow-in layer as the new turf matures. To provide helpful instruction on the subject of grow-in, this article discusses the process in chronological order, from seedbed preparation to green opening.

SEEDBED PREPARATION

The first phase of a successful grow-in is seedbed preparation, which begins well before the first seed or sprig is planted. Preparing a seedbed basically involves firming up the rootzone to minimize development of depressions and tracking after turf establishment, and applying starter materials to promote healthy seedling development.

The most effective method for settling the rootzone after it has been pushed into the green cavity, shaped, and firmed is to bring the rootzone to field capacity with extended irrigation on two occasions before planting. To reach field capacity (i.e., water flows continuously out of the drainpipe), a new green typically requires one hour or more of irrigation from all of the sprinkler heads surrounding the putting surface. The second heavy irrigation cycle is best scheduled the day before planting to insure that the seedlings or sprigs have adequate soil moisture.

The two- to three-foot-wide area at the edge of the green cavity is the most difficult to firm prior to planting. Extra attention should be paid to this critical area during the compaction step.

In addition to heavy irrigation, the rootzone should be compacted with a heavy roller. This, of course, is in addition to thorough floating (shaping) of the green, usually done with a mechanical rake and drag mat. And, in cases where the sand is inherently resistant to compaction, the rootzone should be rolled several times. In most circumstances, a 1-ton roller will produce great results despite the natural hesitation of the superintendent or project manager to operate such a large machine on new greens. Keep in mind that soft greens can also benefit from rolling *after* turf establishment.

An easy way to judge the proper firmness of a new green prior to establishment is to measure the depth of footprints in the soil. Ideally, footprints should be less than 0.25 of an inch deep. If they are deeper than 0.25 of an inch, additional irrigation and rolling are needed. When testing the firmness of a new green, give special attention to the perimeter of the cavity, where settling after establishment is most common. This zone of about 24 inches at the green cavity edge is usually the most difficult establishment area of the green to compact. Multiple passes in this zone with a mechanical rake, after irrigation, can be effective as the tires target compaction in this narrow band.

Once the rootzone has been compacted, pre-plant fertilizers are applied to create perfect agronomic conditions for seedling or sprig development. Pre-plant materials, including micronutrients and chemical soil amendments, are assembled based on soil tests. Starter fertilizers should not exceed 2 lbs. phosphorus per 1,000 sq. ft. as more will be unusable. If soil tests call for more phosphorus, apply the balance 30 days after initial pre-plant. A 1 lb. N per 1,000 sq. ft. application of slow-release nitrogen completes the pre-plant package. This provides a nitrogen source for the first 10 to 12 days after planting so that fertilizer does not have to be applied during this tender phase of germination/turf development. Readily available nitrogen is on hand in the soil solution as soon as the turf has developed enough for uptake.

EROSION PROTECTION

Erosion and sediment control are normally not considered part of green establishment, but they are essential elements. Damaging erosion can occur on a high-sand rootzone, even when the entire complex is sodded. Erosion damage is especially likely at the putting green/collar transition or sod line during establishment. Silt fencing slows and distributes runoff to prevent washing of the mix.

ESTABLISHMENT

Once the ground has been prepared, the second phase of a successful grow-in is to establish the turf. Bentgrass seeding is best done in two directions with a drop seeder. It is often mixed 50:50 with a granular material such as a greens grade organic fertilizer to increase volume for easier distribution. Rates for seeding creeping bentgrass should not exceed 0.75 lb. of pure live seed (PLS) per 1,000 sq. ft. in each of the two directions. Sprigging rates for the ultradwarfs should be 25 bushels (Georgia bushel measure) per 1,000 sq. ft. minimum or 8-12 live sprigs per sq. ft.

After seeding, tracking with the knobby-tire mechanical rake is the most common process. Extra tracking at the green cavity/collar transition, before and after seeding, with good soil moisture, usually provides adequate firmness. Again, careful attention to compaction at the green well edge will save much work later trying to smooth this transition from collar to putting surface.

Tracking-in seed is efficient, but another option is to lightly rake with the *back* of a leaf rake, helping ensure good seed/soil contact. This is done with no down pressure to prevent planting the seed too deep. *Light* rolling completes the finishing task of seeding. This firms the surface, maximizes seed/soil contact and removes the "fluff" at the surface, which reduces the tendency for drying out in the upper 0.25 of an inch. Rolling often is not utilized enough when seeding.

With the seed or sprigs planted in the ground, the next key element of establishment is water management. During the first eight to ten days, the emerging turf will require frequent irrigation to prevent desiccation. The key to water management during grow-in is stepping down water frequency and amounts properly after initial rooting or germination to enhance maturity. The question of when to start this water reduction is a common query of inexperienced grow-in managers. It is usually not the timing of water reduction that creates problems, but instead it is the manner in which water reduction is initiated.

It is vitally important that in the initial stages of water reduction, the *run* times of irrigation cycles be reduced first and not the *start* times. For example, a program is set up for new bentgrass green establishment in which five to six start times a day are programmed, and generally about 20 to 22 minutes per *green* (3-4 minutes per head) is the desired run time. The initial thought might be to first reduce the number of *start* times after significant establishment to assist with root development. However, this can create drought stress on the bentgrass, especially on a late spring seeding. The same is true with bermudagrass sprigging, particularly in August. Remember that the grass is quite immature and there is not enough root system exploitation of the soil volume to allow for adequate moisture recovery. This is especially true in a new high-sand or straight-sand green profile, which initially is more susceptible to drying out at the surface. Significant drought stress can occur within the plant before visual signs are apparent with this type of water reduction versus proper initial reduction.

The proper reduction sequence is to first reduce the *run* times of each cycle to achieve a reduction in the amount of water being applied. It is much more efficient to reduce *run* times — the amount of each application — with the number of applications remaining the same. This reduces the chances of drought stress because the tender seedlings or new sprigs do not go too long between irrigation cycles, and the upper half inch of soil moisture is more adequately maintained. After some hardening of the plants, *start* times can be reduced to achieve further maturity and rooting.

Remember also that *start* times are not necessarily evenly spaced over the 24-hour clock. The *start* times, especially on bentgrass spring seeding, must be concentrated during the late morning and early and late afternoon periods because of the greater tendency for drought stress during the heat of the day. Commonly, the first watering occurs about 7:00 AM - 8:00 AM, and concentrated water begins about 10:30 AM - 11:00 AM. The last cycle is set for about 6:00 PM - 7:00 PM, with no water applied during the night. Night irrigation is not needed and can promote disease activity.

SPRAYING

Initial pest- and disease-control products and nutrient applications should be made with a walking boom. Freqently, new greens are too soft for a self-contained sprayer for the first six to eight weeks after seeding. If the superintendent is not prepared with a walk-type boom, he may be forced to rut the greens to apply a control product in the event of a disease outbreak. This specialized piece of equipment should not be overlooked for this phase of green development.

A fungicide application after planting is usually made to prevent damping-off. This can be a very active and devastating pythium disease problem if environmental conditions are favorable. The fungicide can be applied in spray or granular form at this stage. Also, treated seed is preferred, if available.

Improperly firming the rootzone mix prior to planting results in severe scalping of the turfgrass.

MATURATION

The third and final phase of a successful grow-in involves nurturing newly established seedlings or sprigs into a mature turf canopy that will hold together under the rigors of daily play. The key to this endeavor is the light application of fertilizer on a frequent schedule. It is commonly thought that fertilizer is applied during grow-in on a seven-day frequency, with about 1 lb. nitrogen or potassium per 1,000 sq. ft. per application as the standard rate. Grow-in is accomplished at a much more successful and rapid rate when this frequency is, in the initial phases, reduced from a seven-day application rotation to a five-day rotation at lighter rates, usually 0.3-0.6 lb. N per 1,000 sq. ft. Rates depend on turf species and weather.

Potassium nitrate (KNO_3) has been utilized for bentgrass grow-in with excellent success using the above outline. Ammonium sulfate (NH_4SO_4) should be a primary nitrogen source for bermudagrass, along with adequate iron, magnesium, and manganese. This is rotated every third application as a complete material. After four to five weeks, the strategy changes by reducing the frequency. Micronutrient sprays and/or chemical soil amendments are applied as needed to assist in turf maturity. A complete analysis, granular, slow-release material should be the foundation to address soil and plant nutrient needs during this high-input phase of development. This also combats the tendency for nutrient depletion from the higher irrigation cycles still being utilized. Remember, watering in fertilizer materials is vitally important, and applications during the heat of the day are to be avoided.

Grow-in fertility rates are considerably higher than maintenance rates for obvious reasons. Generally, on a USGA spec green the nitrogen rate the first year after seeding will be approximately 8-11 lbs. of N per 1,000 sq. ft., depending on region, rainfall, physical properties of the greens mix, and water management. Research has shown relatively little leaching loss of fertilizers when good water management is utilized. Straight-sand construction requires more fertility because of reduced water retention and nitrogen holding capacity.

Grow-in managers often struggle with applying this high rate of fertilizer on establishing bentgrass greens when they have been utilizing maintenance levels of 1-3 lbs. N per 1,000 sq. ft. for so long. Young seedlings can develop stress from inadequate nutrition very quickly in new sand rootzone environments, and proper levels must be maintained. The same, of course, is true with bermudagrass sprigs. Nitrogen levels will approximate 9-12 lbs. of N per 1,000 sq. ft. for the first year on Tifdwarf or ultradwarf greens.

A 1:1 ratio of nitrogen:potassium has been the usual approach in the first year of fertility management. Routine phosphorus and minor elements are applied according to soil and tissue tests. Follow-up soil tests are very helpful at about 4 months and 10 months after planting. Tissue analyses during grow-in can help monitor nutrient availability. Nitrogen levels during grow-in should be 5.25-6.5% in bentgrass and 6-7% in bermudagrass as benchmarks for monitoring. These levels are higher than is ideal for maintenance. A slow-release, granular fertilizer with a complete analysis should also be included in the fertilizer schedule during turf maturation to offset the rapid leaching of nutrients caused by frequent irrigation. When applying granular fertilizers, make certain to avoid the heat of the day and irrigate immediately afterwards to prevent burn.

With the turf properly fed and watered, it usually does not take long for it to require mowing on a regular basis. The act of mowing should never be underappreciated during the grow-in of new greens, as it can have a direct impact on turf quality. The most common mistake with respect to mowing is waiting too long to mow the turf for the first time and doing so at too high a cutting height.

The determining factor for when to mow a new green for the first time should be the height of the turf, not its density. However, it is easy for the turf manager to look at a green and believe it is not quite ready. Grow-in managers often allow density to be too great a part of the equation of determining when mowing is needed. Density has nothing to do with mowing new greens — it is strictly vertical growth development. Remember this in evaluating when mowing should commence.

As a guideline, mowing should begin when the height of the turf just surpasses the upper limit of its preferred cutting height range. For example, many of today's creeping bentgrass and hybrid bermudagrass varieties have a cutting height range between 0.120 and 0.180 of an inch. Using the upper limit of 0.180 of an inch as the height adjustment for the mower, the first mowing should commence when the turf reaches a height of approximately 0.200 of an inch. Within four to six weeks after the first mowing, the cutting height should be whittled down to the midpoint of the turf's cutting height range or, in our example, 0.150 of an inch.

This guideline may not be appropriate if the rootzone is prone to rutting after mowing begins. In this instance, the turf has to be protected from scalping while it is trying to mature. Nonetheless, the objective for any grow-in should be to work the cutting height down to the middle of the turf's cutting height range as quickly as possible to promote lateral growth and stand maturity. The mowing rule of thumb has been to never remove more than ⅓ of the leaf at any mowing. During establishment this target is better set at ¼ to reduce the chance of scalping or shock.

Late morning or afternoon mowing is also important in the early stages. A dry turf will mow cleaner and have less likelihood of pulling seedlings out of the ground. Frequent mower back-lapping will be required. Solid front rollers should be used on the putting green mowers for the first months, as the grooved rollers are too damaging. They can also dig into the somewhat exposed rootzone surface. The first two to three cuts are done without baskets to reduce weight; after that, baskets are used.

Desiccation on mounds or green slopes occurs very quickly when the time between the irrigation cycles is lengthened too quickly after planting.

Scouting during the early stages of development is a critical part of grow-in management, to keep a close eye on disease development and insect activity. When establishing new greens, scouting is actually so important that it should be a daily routine. If left unchecked, there are numerous pathogens that can literally destroy a stand of young plants in a matter of hours.

Daily scouting is also essential for monitoring weed contamination. *Rouging* is a term used by superintendents in the South and refers to checking greens for weeds on a daily basis. The most common weeds found in southern greens are nutsedge and off-type bermudagrasses. Creeping bentgrass greens can also become contaminated with invading bermudagrass from the surrounding area or by *Poa annua* blown in on the wind.

Topdressing completes the management circle when it comes to producing a smooth, successful grow-in. Throughout the grow-in of a new green, topdressing should be applied at a light rate of 0.5-0.7 cu. ft. per 1,000 sq. ft. Working the sand into the young turf without bruising, however, is often a bigger issue than rate and frequency of application. Herein is the great value of a spin-type topdresser capable of applying sand evenly enough to work down into the turf with irrigation alone. As maturity progresses, the turf will become more wear resistant, but not so much that one should consider using a steel dragmat to work topdressing into the turf canopy.

The first topdressing application for creeping bentgrass greens can normally be scheduled four to six weeks after seeding. Hybrid bermudagrass greens are usually ready for the first topdressing application three to four weeks after sprigging. Light topdressing applications on sodded collars and approaches should be scheduled within five to six weeks for cool-season grasses and two to three weeks for warm-season grasses.

AERIFICATION

One of the goals of early turf development is to maximize the growth rate by using relatively large amounts of water and fertilizer. Under these conditions, the turf unavoidably produces thatch at an accelerated rate. Moreover, due to early topdressing restraints, the thatch layer is less porous and denser in composition, producing a layer more subject to hydrophobic or anaerobic conditions. This unique thatch condition gives rise to the term *grow-in layer.*

The grow-in layer begins developing on new greens in a matter of a few weeks and is often underestimated in terms of its long-term impact on turf performance. The high accumulation of organic matter just beneath the turf surface is not readily evident to the eye, but rather to the touch. The detrimental effects of a grow-in layer usually become apparent after a green has been opened to daily play, as would a similar layer created by sodding a new green. The principal detriment is the sealing off of the soil surface that, in turn, causes water to stagnate in the grow-in layer. This is why scheduling aerification a few months after the establishment of a new green is often critical to its long-term success.

This early aerification may seem radical, but compaction relief is not the reason for aerification at this point. The goal is to permanently break up the surface tension created by this newly developed grow-in layer of thatch. It is not only critical to aerify new greens at this early stage, but hollow tines must be used to physically remove a core from the green. Solid tines are not beneficial in this case.

On the whole, the first two aerification treatments of seeded creeping bentgrass greens are done with ⅜-inch-diameter hollow tines on 2-inch centers. Afterwards, greens develop greater firmness and surface stability and can be aerified with larger tines on 1-inch centers. The same general principle also would be true for hybrid bermudagrass greens.

TOUCH-UP

As is often the case, some things tend to go astray despite the best-laid plans. During the grow-in of new greens, there are always spots on the putting surface with poor or no turf coverage that will require touching up. This occurs for many reasons, such as vandalism, animal damage, erosion during a severe storm, etc. The most common area is the collar/putting surface transition edges because of the instability reasons described above. If firmness was not achieved prior to the first mowing, severe scalping will occur. A grooming reel from a putting green mower attached to a handle makes a great tool for roughing up bare areas that need to be reseeded or resprigged.

OPENING THE GREENS

Before the grow-in is complete, it will probably be necessary to withstand golfer pressure to open up the green(s) ahead of schedule. Understandably, the pressure arises when the putting surface(s) appear mature to golfers. Remaining patient for an additional four to six weeks, however, is critical to give the new turf time to produce horizontal stems that bind the plants together and allow them to survive concentrated foot traffic around the hole locations.

Growing in a new putting green is a long and arduous process and requires a high level of management skill. Plenty can go wrong without careful monitoring. With knowledgeable planning and quality control management, however, most problems can be avoided. The craftsmanship and the enjoyment of the project will certainly be the better for it. Good luck!

Special thanks to Keith Ihms, CGCS; Kevin Nettles; Scott Bush; and Neal Dube for their assistance in gathering photographs for this article.

BUD WHITE *is the agronomist for the Mid-Continent Region and has worked with superintendents on more than 200 construction/renovation projects. He is also the author of* Turf Manager's Handbook for Golf Course Construction, Renovation, and Grow-in.

The grooming reel is an excellent touch-up tool to use for spot seeding or breaking surface algae formation.

Are Alternatives to Traditional Nematicides a Real Possibility?

Although many of the traditional products may no longer be used, new ones may be available soon.

BY WILLIAM T. CROW

Nematode management on golf course turf has not gotten easier in recent years. Many of the effective nematicides formerly labeled for golf course use are no longer available. Fenamiphos, the active ingredient in the Nemacur® products, has been the most widely used nematicide on golf courses over the last 30 years. This product is currently being phased out of production.

At the same time, nematode problems are becoming more widespread. The sting nematode, the most devastating nematode to turfgrasses, is being spread to putting greens and sandy fairways outside of its natural geographical range through infested planting material. What does the future hold for nematode management on golf course turf? Will golf course superintendents be able to treat for these invisible invaders?

During the past two decades most of the major players in pesticide development and manufacturing have not put much effort into nematicide discovery. This trend has changed to some extent in recent years due to opportunities presented by the phase-out of methyl-bromide and organophosphates. At the University of Florida and other institutions, nematologists are working with chemical companies to evaluate new chemistries and uses for existing nematicides. However, the road to registration is fraught with delays and difficulties. Even if a new nematicide works, it can be years before it gets on the market, if it does at all.

Dr. Brian Unruh at the University of Florida is investigating various nematode treatments under golf course conditions at Walton Beach Golf Club.

The lack of effective new nematicides has opened up opportunities for smaller companies to get alternative products for nematode management on the market. These products include soil amendments, biological organisms (bacteria, fungi, nematodes), or biologically derived compounds (plant extracts, vat fermentation products, etc.). Because most of these are exempt from EPA scrutiny, they are relatively cheap and quick to get on the market. Unfortunately, rigorous and objective evaluation of their efficacy is lacking for many of these products.

In 2002 and 2003 the University of Florida evaluated the effectiveness of numerous alternative nematicide control products on golf course turf. This project was funded with grants from the Florida Golf Course Superintendents Association, the Golf Course Superintendents Association of America, and with grant-in-aid from the USGA. In these studies the effects of these products on nematode populations, turf visual performance, and root development were evaluated. Various rates, timing, and application protocols approved by the respective companies were used for each product. Treatments were applied monthly, biweekly, or weekly for six months. The products tested included root stimulants, nematode biological controls, plant extracts, induced resistance products, and biological nematicides with comparisons to untreated controls and Nemacur-treated turf.

In 2002 the experiment was conducted on an experimental putting green at the University of Florida G. C.

Nematodes frequently attack the root system, resulting in stunted root growth (right). The shoots may become stunted in irregular patches and appear yellowish or chlorotic.

Horne Turfgrass Research Facility. This green had Floradwarf bermudagrass infested with damaging numbers of lance nematodes (*Hoplolaimus galeatus*) and stubby-root nematodes (*Trichodorus proximus*). During 2002 the products evaluated included:

1. Nemastop (Soil Technology Corp., Ames, Iowa)
2. Safe-T Green (Safe Materials Inc., Valdosta, Ga.)
3. Nematac S (Becker Underwood, Ames, Iowa)
4. Avermectin (Syngenta Professional Products, Basil, Switzerland)
5. Neo-Tec (Parkway Research Corp., Houston, Tex.)
6. Floradox (Floratine Products Group, Collierville, Tenn.)
7. Keyplex 350 DP (Morse Enterprises, Miami, Fla.)
8. Turf Vigor LN (Novozymes Biologicals Inc., Salem, Va.)
9. Superbio Microbial Blend (Advanced Microbial Solutions, Pilot Point, Tex.)
10. Synzyme (Howard Fertilizer Co., Orlando, Fla.)
11. Quillaja 35 (Desert King International, San Diego, Calif.)
12. A mustard-based material (Nematrol Inc., Guelph, Canada)

In 2003 the experiment was conducted on a Tifway 419 athletic field with damaging populations of sting nematodes (*Belonolaimus longicaudatus*). Product evaluations included:

1. NeoTec (Parkway Research Corp., Houston, Tex.)
2. Safe-T Green (Safe Materials Inc., Valdosta, Ga.)
3. Keyplex 350 DP (Morse Enterprises, Miami, Fla.)
4. Turf Vigor LN (Novozymes Biologicals Inc., Salem, Va.)
5. Synzyme (Howard Fertilizer Co., Orlando, Fla.)
6. Quillaja 35 (Desert King International, San Diego, Calif.)
7. Neo-Tec S.O. (Parkway Research Corp., Houston, Tex.)
8. Dragonfire CPP (Poulanger U.S.A., Lakeland, Fla.)
9. Cyclewise Nema (Hoodridge International, Parkland, Fla.)
10. AgroNem (Agro Logistic Systems Inc., Diamond Bar, Calif.)
11. Superbio Soil Builder (Advanced Microbial Solutions, Pilot Point, Tex.)
12. Ditera (Valent BioSciences Corp., Libertyville, Ill.)
13. A mustard-based material (Nematrol Inc., Guelph, Canada)

In 2002 none of the experimental treatments reduced nematode populations compared to the untreated controls. However, the mustard product enhanced turf color and density throughout the six-month test period. The data being collected for 2003 have not yet been analyzed. In 2003, we worked with an improved formulation of the mustard product and used new application methods. With the changes in 2003, significant reductions in nematode population densities, in addition to beneficial turf responses, were observed.

The mustard product may benefit the turf in several ways. Nematode effects can be largely attributed to biofumigation. As the mustard bran breaks down, it releases a nematicidal gas called allyl-isothiocyanate. This gas is similar to that released by certain synthetic soil fumigants sometimes used in turf renovation. The gas dissolves in water and is moved into the soil profile by irrigation. The material also has some fertility effects, and the rates used in the study delivered about 0.5 to 1.0 lb. of N per 1,000 sq. ft. We are still learning about this product and how it works. Data thus far indicate that it may be more effective against some nematode species than others.

So, will there be any effective nematode management products on the market by 2010? I feel confident that there will be. Several of the products evaluated in this study and in other research show promise. The chemical companies are restarting their nematicide screening programs, and we are learning more about nematode biological control. At the same time, superintendents need to be warned that many of the options on the market are not all they are cracked up to be, and they should first be carefully evaluated on a small scale.

DR. BILLY CROW *is an assistant professor of nematology at the University of Florida, Gainesville.*

Gray Leaf Spot of Perennial Ryegrass Turf: An Emerging Problem for the Turfgrass Industry

Research is unraveling the mysteries of this serious disease of ryegrass fairways and roughs.

BY WAKAR UDDIN, GNANA VIJI, AND PAUL VINCELLI

Perennial ryegrass (*Lolium perenne* L.) is a cool-season grass originating from open areas and forest fringes of southern Europe and western Asia. It is widely used in the turf industry, especially on golf course fairways, due to its agronomic attributes such as turf color, upright and bunch growth habit, rapid germination and coverage, tolerance to close mowing and soil compaction, and absence of thatch. Additionally, tolerance to cold weather has led to the use of perennial ryegrass for overseeding dormant bermudagrass golf tees and fairways during the fall in the southern United States.

Gray leaf spot, or blast, caused by the fungal pathogen *Magnaporthe grisea* (Hebert) or *Pyricularia grisea* (Cooke) Sacc, is a newly emerging disease of perennial ryegrass in several regions of the United States. The name of the fungal pathogen changes depending on the stage of the disease life cycle.

In recent years, severe outbreaks of gray leaf spot resulted in extensive damage to perennial ryegrass golf course fairways and athletic fields, particularly in the midwestern and northeastern United States. Under favorable condi-

Gray leaf spot disease causes turfgrass stands to develop an off-color, wilted appearance followed by the development of pocketed areas or irregularly-shaped patches. Inset: Photomicrograph of conidia that cause gray leaf spot disease.

tions, the disease develops rapidly, and entire ryegrass swards can be killed within a few days, leaving only annual bluegrass and other grassy weeds that are not affected by the disease.

Turfgrass managers are now considering replacing perennial ryegrass with other turfgrass species such as creeping bentgrass and Kentucky bluegrass due to the extensive and unpredictable damage caused by gray leaf spot. However, replacement of perennial ryegrass with these turfgrass species does not provide the best solution because of the excellent agronomic characteristics of perennial ryegrass in contrast to the rapid thatch buildup and patch disease problems in other turfgrass species.

HOSTS

Magnaporthe grisea is pathogenic to more than 50 grass hosts, including small grains, forage, and turfgrasses.[1,2,5] The fungus is probably best known for the devastating losses it can cause on rice (*Oryza sativa* L.). It may infect at any growth stage of the rice plant, causing rapid blighting that is referred to as blast.

Gray leaf spot is a common foliar disease of St. Augustinegrass in the southeastern United States[4,10]; however, it does not cause damage to the extent reported in perennial ryegrass. In 1991, Landschoot and Hoyland[3] reported gray leaf spot on perennial ryegrass turf in Pennsylvania golf course fairways. The epidemic was confined to the southeastern region of Pennsylvania, where extensive damage was reported. Since this first report, outbreaks of gray leaf spot have occurred sporadically, resulting in serious loss of turf in 1995, 1998, and 2000 in the Mid-Atlantic region. The disease has recently been reported in the Midwest, New England, and the western United States.

SYMPTOMS

Gray leaf spot develops on perennial ryegrass leaf blades as small, water-soaked lesions that subsequently turn into dark-colored, 1-3mm-diameter necrotic spots. The spots expand rapidly and become gray, grayish-brown, or light brown, circular to oblong lesions with purple to dark brown borders that often are surrounded by a yellow halo. The necrotic lesions coalesce, become irregular in shape and cause partial blighting (tip blighting) or complete blighting of the leaves. Blighted leaf blades also may exhibit twisting or

Initial signs of gray leaf spot on perennial ryegrass leaf blades are the appearance of small, water-soaked lesions that subsequently turn into dark-colored necrotic spots.

flagging. Complete leaf necrosis results in the death of the entire plant. There is no evidence of infection of crown tissue by the pathogen. Blighted leaf blades may appear grayish-white to tan and have a dusty or velvety texture when conidia are produced profusely. Aerial mycelium is usually not evident on necrotic leaves under humid conditions.

Diseased turfgrass stands develop an off-color, diffuse blighted or wilted appearance followed by the development of sunken or pocketed areas or irregularly shaped large patches. In a severe case, the entire ryegrass stand may be killed, leaving annual bluegrass and other grassy weeds in the fairways. The disease may be distributed along low-lying or drainage areas where high relative humidity and prolonged leaf wetness periods occur in the turf canopy.

DISEASE DEVELOPMENT

Magnaporthe grisea overwinters as dormant mycelium in dead leaves. Conidia produced from the leaf debris apparently serve as the primary inoculum for leaf infections early in the growing season, although details of this early infection process need to be determined.

It also is possible that at least some infection foci are established via long-distance dispersal of conidia. Based on field observations, we hypothesize that gray leaf spot develops at visually undetectable levels in early to mid-summer. Conidia produced on infected leaves during this period eventually trigger a series of secondary infections that contribute to the buildup of inoculum during the late summer periods.

Gray leaf spot is often observed first in turf in golf course rough maintained at higher mowing heights. These areas may be partially shaded and have extended leaf wetness periods and high humidity that are more conducive for infection. The disease may be detected in roughs several days before extensive damage of turf in fairways becomes evident.

Dispersal of inoculum is by wind, wind-blown rain, water-splash from sprinkler irrigation, movement by ground maintenance equipment, and other golfing activities. Dispersal of conidia by mowers, spray rigs, spreaders, core aerifiers, and golf carts is important in the spread of the disease in golf courses.

Gray leaf spot normally develops from early August to mid-October. Environmental conditions prevailing during this late summer period and availability of inoculum are major determinants in the development of gray leaf spot epidemics. Efforts to quantitatively describe the relationships between environmental factors and gray leaf spot showed that temperatures between 79°F and 84°F (26°C and 29°C) were optimal for disease development.

Leaf wetness duration also is important in disease development. Uddin et al.[6] reported that the disease incidence and severity increased with increased leaf wetness duration at all temperatures. Shorter leaf wetness duration was required for disease development under warmer temperatures.

In addition to leaf wetness duration, relative humidity influences gray leaf spot development. Although expansion of necrotic lesions is rapid under prolonged leaf wetness periods, conidia are not produced when excessive free moisture is present on the left tissue. Removal of free moisture from the infected leaf blades under high humidity is necessary for production of conidia. Therefore, warm day and night temperatures, subsequent wetting and drying of leaf blades, and high humidity regimes are major factors in the development of gray leaf spot epidemics and perpetuation of the disease.

DISEASE MANAGEMENT STRATEGIES

Cultural management practices often do not provide adequate control of gray leaf spot due to rapid development of the disease and high susceptibility of currently available cultivars. An integrated approach that entails various cultural management practices and a sound fungicide program provides effective control.

FUNGICIDAL CONTROL

Among currently labeled fungicides, the most effective materials for gray leaf spot control are azoxystrobin, trifloxystrobin, and thiophanate methyl. Azoxystrobin is labeled for gray leaf spot as Heritage 50WG at the rates of 0.2-0.4 oz. per 1,000 sq. ft. (0.61-1.22 kg. of formulated product per ha.) at 14- to 28-day intervals. While the 0.2 oz. per 1,000 sq. ft. (0.61 kg. per ha.) rate of Heritage 50WG has proven very effective in some tests, biweekly applications of the 0.2 oz. per 1,000 sq. ft. (0.61 kg. per ha.) rate sometimes have resulted in small, but significant, amounts of foliar blighting.

In contrast, application of Heritage 50WG at the 0.4 oz. per 1,000 sq. ft. (1.22 kg. per ha.) rate typically has provided excellent disease control for at least three weeks under high disease. The performance of trifloxystrobin (Compass 50WG) in field tests typically has been very satisfactory. In some studies, there was no statistical difference between Compass used at labeled rates at two-week intervals and the top-performing treatment in the test. However, in several tests, use of the compound according to label directions provided slightly lower disease control than the top treatment in the test. The product has not always provided acceptable disease control when used at labeled intervals exceeding two weeks, even at the highest labeled rate.

Thiophanate methyl (Clearys 3336 50WP) and similar products typically have provided excellent control under high disease pressure when used at a minimum of 3 oz. active ingredient per 1,000 sq. ft. (9.15 kg. per ha.) at 14-day

One unique characteristic of gray leaf spot is a distinct twisting of the leaf tip, often resembling a fishhook shape.

intervals. Rates as low as 2 oz. per 1,000 sq. ft. (6.1 kg. per ha.) have been effective under low to moderate disease pressure. In one test, thiophanate methyl applied biweekly at 3 oz. per 1,000 sq. ft. (9.15 kg. per ha.) provided excellent control for most of the season, but diminished somewhat at the end of the epidemic, suggesting that under the highest disease pressure, the 4 oz. per 1,000 sq. ft. (12.2 kg. per ha.) rate may be necessary.

Formulations of two demethylation inhibitor (DMI) fungicides, propiconazole and triadimefon, are labeled for gray leaf spot. These DMI fungicides, when used alone following label directions, have usually provided poor control under high disease pressure. Chlorothalonil and mancozeb, both contact fungicides that act as non-specific enzyme inhibitors, are also labeled for this disease. Although some studies have shown good results with these materials, chlorothalonil and mancozeb have not consistently provided acceptable control under high disease pressure. Tank-mixes of a DMI fungicide and chlorothalonil at labeled rates can often provide excellent control, but control is sometimes not complete under high disease pressure.

Some turf managers will initiate a spray program a week or two before the time of year when epidemics historically have begun in the area; others will begin spraying when the disease is first reported in the region. Both approaches carry risks. The frequency and longevity of a spray program often depend on a combination of the past history of the disease at the site and in the region, and the weather conditions favorable to disease development.

In the Midwest and Northeast, the window where fungicide protection is needed is usually from early August to early September and often beyond. In seasons with low disease pressure, no fungicide protection may be needed beyond early September, whereas under high disease pressure, fungicides are needed into October.

TURFGRASS HEIGHT AND GRASS CLIPPING MANAGEMENT

Results from experiments on the effects of mowing height on gray leaf spot severity have been contradictory. A study conducted in the northeastern region of the U.S. indicated gray leaf spot was more severe at a mowing height of 3.5 inches (8.9 cm.) compared to 0.5 inch (1.27 cm.)[9]. In Kentucky, Williams et al.[11] found no differences in disease severity on perennial ryegrass mowed at 0.75 inch (1.9 cm.) and 2.5 inches (6.4 cm.). This discrepancy may have been due to various cultural and environmental factors influencing disease development.

Turf managers in the northeastern and mid-Atlantic states are generally advised to avoid raising mowing heights, particularly during the periods of gray leaf spot epidemics. Grass clipping management is important, as the removal of clippings can reduce disease incidence substantially under low disease intensity; however, under high disease intensity the effect of clipping removal is not significant. Although clipping removal effectively reduces disease intensity under low to moderate disease intensity, collecting the clippings from large fairways and disposing of them is impractical in the operation of most golf courses.

FERTILITY

Increasing the amount of nitrogen increases gray leaf spot severity. The source of nitrogen also influences gray leaf spot development. A recent study has shown that gray leaf spot severity was lower when controlled-release forms of nitrogen such as isobutylidene diurea (IBDU) and sewage sludge-based Milorganite were applied compared to quick-release forms such as ammonium nitrate and urea.[8]

HERBICIDES

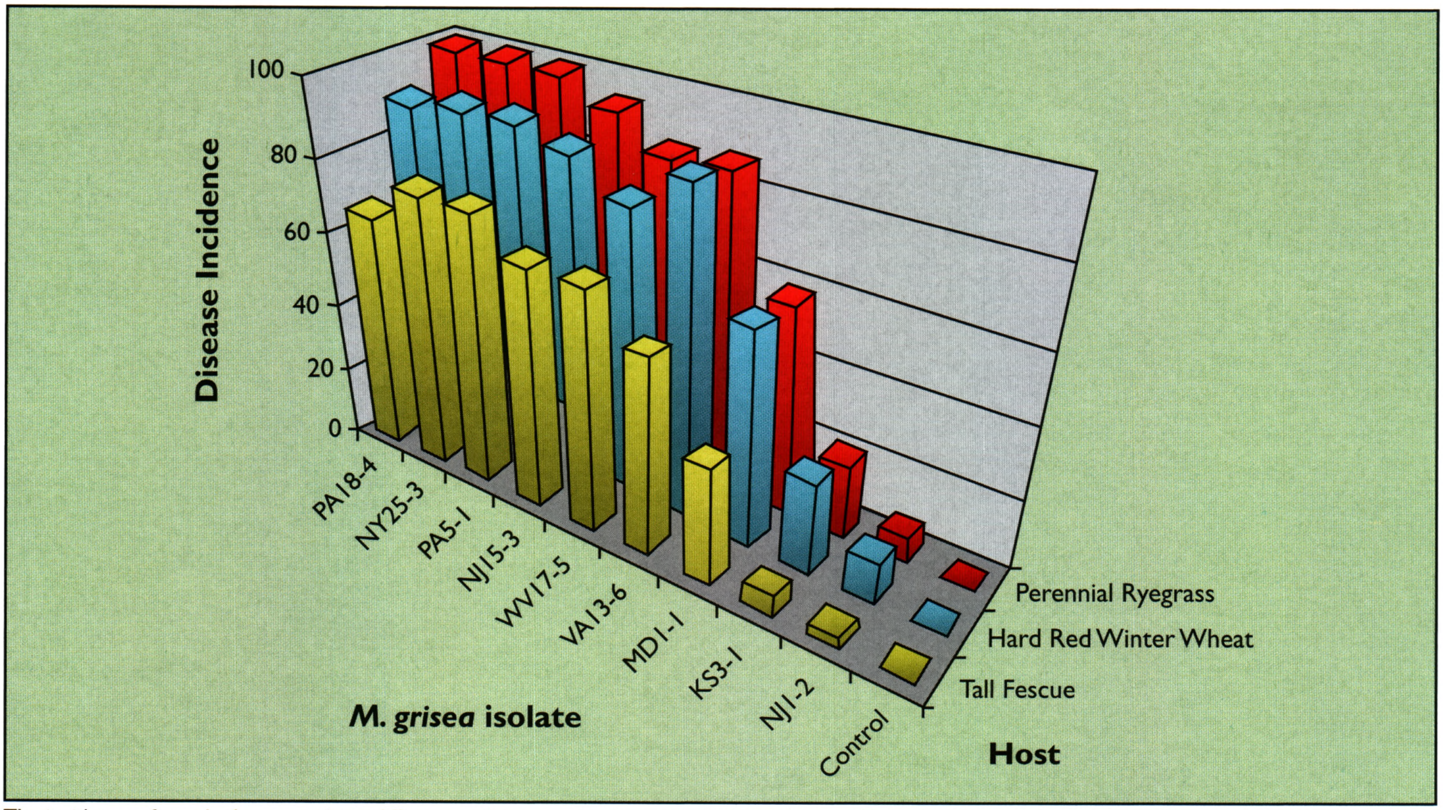
The herbicide ethofumesate (Prograss) is widely used to control annual bluegrass in perennial ryegrass fairways. Its use in the spring has been associated with increased severity of gray leaf spot. This effect was not evident when the herbicide was applied during the fall. The mechanism for the increase in severity of gray leaf spot is unclear. The herbicide interferes with fatty acid biosynthesis in plants and causes aggregation of the epicuticular wax on leaves. More efficient penetration of host plant surfaces at the thinning areas of leaf tissue by *M. grisea* may have resulted in higher gray leaf spot severity. A more rigorous fungicide spray program for gray leaf spot may be required in areas where ethofumesate is applied in spring for annual bluegrass seedhead suppression.

BREEDING FOR RESISTANCE

Cultivars of perennial ryegrass that are resistant to gray leaf spot pathogen are not currently available. Polygenic resistance appears to be present in perennial ryegrass. A number of field studies to identify novel sources of resistance in a worldwide collection of perennial ryegrass cultivars and lines are currently underway. Thus far, some progress in identifying resistant germplasm has been made, and several improved lines and cultivars have been identified.

CURRENT STATUS AND FUTURE OUTLOOK

Development of a weather-based model for predicting gray leaf spot epidemics has been a focus of our research, and currently a model based on temperature and leaf wetness duration is available.[6] Efforts to quantitatively describe the relationship between the relative humidity and gray leaf spot development are currently underway. A major breakthrough in research on gray leaf spot management is the development of effective fungicide programs for the disease. While intensive use of fungicides is not a desirable long-term disease control strategy, spray programs can be used to prevent epidemics until more sustainable management options are available.



The incidence of gray leaf spot on three different turfgrass species inoculated with isolates of *Magnaporthe grisea* from perennial ryegrass.

While significant advances have been made in understanding gray leaf spot, some major challenges still exist. One of the most serious challenges is the identification of resistant germplasm and development of resistant cultivars. Additionally, very little is known about the life cycle of the gray leaf spot pathogen. Further understanding of the life cycle and its significance to the epidemic development in ryegrass fairways in late summer periods will require major efforts in gray leaf spot research.

ACKNOWLEDGMENT

We thank Michael Soika, Frances Moorman, Ed Dixon, Jack Doney, Paul Burrus, David Williams, Yun-sik Kim, Jesse Shelton, Nasreen Kabir, Erin Soika, Lesli Lucas, and Billie Lucas for providing technical assistance in studies that have provided information for this article. Financial support for these studies was provided by the USGA, the GCSAA, The Pennsylvania Turfgrass Council, and the fungicide industry.

EDITOR'S NOTE

An expanded version of this paper, including fungicide resistance, biological control, and cultivar genetic improvement, is available on the USGA's *Turfgrass and Environmental Research Online* (http://usgatero.msu.edu), June 1, 2003, issue (Vol. 2 No. 11).

LITERATURE CITED

1. Asuyama, H. 1963. Morphology, taxonomy, host range, and life cycle of *Piricularia oryzae*. Pages 9-22. *In:* S. H. Ou (ed.). The Rice Blast Disease. The Johns Hopkins Press, Baltimore, Md.

2. Farr, D. F., G. F. Bills, G. P. Chamuris, and A. Y. Rossman. 1989. Fungi on Plants and Plant Products in the United States. American Phytopathological Society. St. Paul, Minn.

3. Landschoot, P. J., and B. F. Hoyland. 1992. Gray leaf spot of perennial ryegrass turf in Pennsylvania. *Plant Dis.* 76:1280-1282.

4. Smiley, R. W., P. H. Dernoeden, and B. B. Clarke. 1996. *Compendium of Turfgrass Diseases.* American Phytopathological Society, St. Paul, Minn.

5. Uddin, W., F. E. Moorman, M. D. Soika, and G. Viji. 1999. Influence of turfgrass age on development of gray leaf spot (blast) of tall fescue. *Phytopathology* 89:S78.

6. Uddin, W., K. Serlemitsos, G. Viji. 2003. A temperature and leaf wetness duration-based model for prediction of gray leaf spot of perennial ryegrass turf. *Phytopathology* 93:336-343.

7. Uddin, W., and M. D. Soika. 2000. Effects of plant growth regulators, herbicides, and fungicides on development of blast disease (gray leaf spot) of perennial ryegrass turf. *Phytopathology* 90:S78.

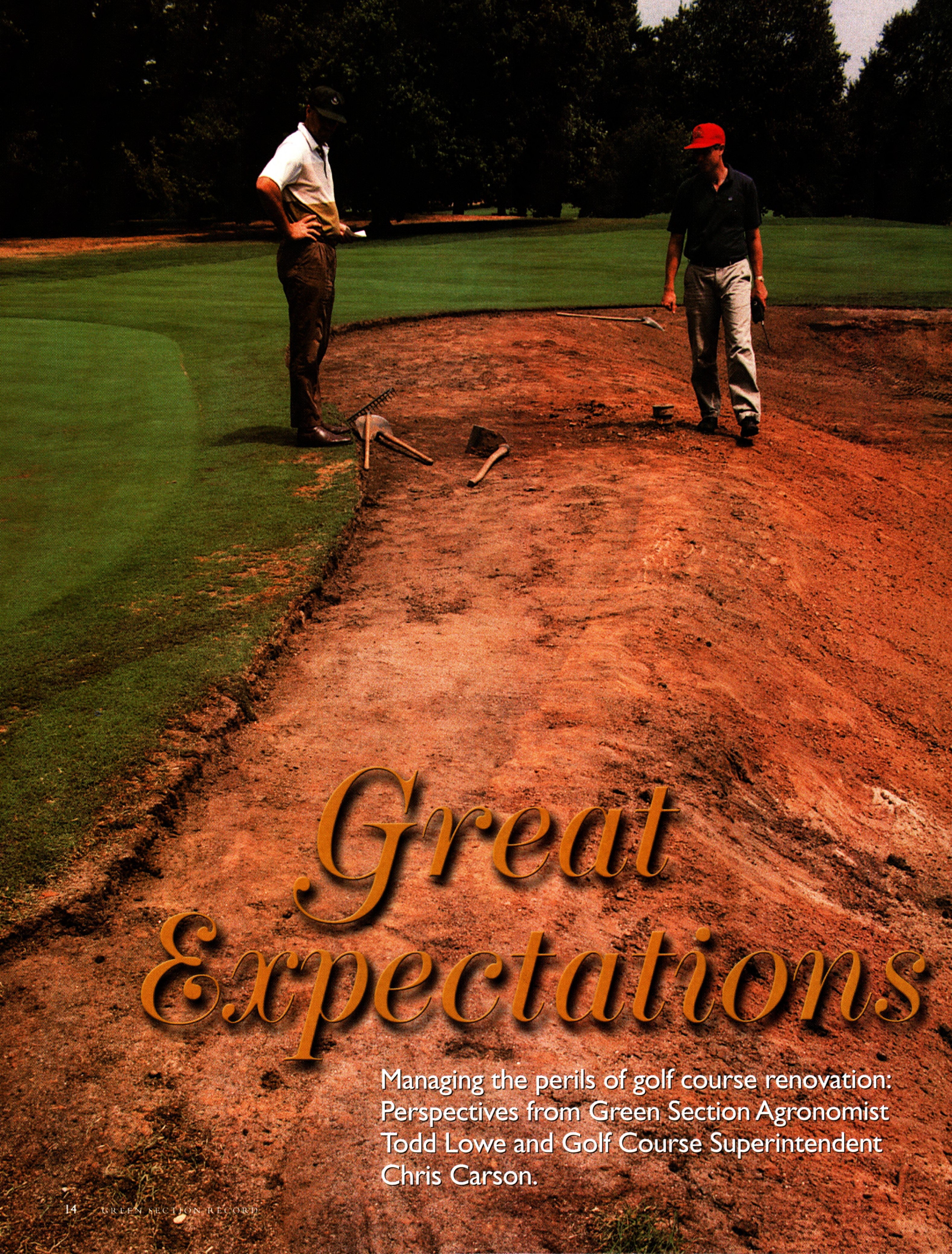
8. Uddin, W., M. D. Soika, J. Shelton, and E. L. Soika. 2001. Severity of gray leaf spot (blast) of perennial ryegrass turf as influenced by nitrogen source. *Phytopathology* 91:S90.

9. Vaiciunas, S., and B. B. Clarke. 2000. Impact of cultural practices and genotype on the development of gray leaf spot in cool-season turfgrasses. Proc. Rutgers Turfgrass Symposium. New Brunswick, N.J.

10. Vargas, Jr., J. M. 1994. *Management of Turfgrass Diseases*. Lewis Publishers, Ann Arbor, Mich.

11. Williams, D. W., P. B. Burrus, and P. Vincelli. 2001. Severity of gray leaf spot in perennial ryegrass as influenced by mowing height and nitrogen level. *Crop Sci.* 41:1207-1211.

WAKAR UDDIN, PH.D., *assistant professor, and* GNANA VIJI, PH.D., *plant pathology post-doc., Dept. of Plant Pathology, The Pennsylvania State University, University Park, Pa.; and* PAUL VINCELLI, PH.D., *extension plant pathologist, Dept. of Plant Pathology, University of Kentucky, Lexington, Ky.*



Great Expectations

Managing the perils of golf course renovation: Perspectives from Green Section Agronomist Todd Lowe and Golf Course Superintendent Chris Carson.

FACE-LIFT OR LETDOWN

Help golfers develop fair expectations for successful golf course renovations.

BY TODD LOWE

Golf course renovations are necessary from time to time. There are different reasons for renovating, such as the need for improving drainage, enlarging putting greens and tees, or regrassing putting surfaces with an improved turfgrass variety. Also, the play character of some areas of the golf course degrades over time through normal wear and requires routine touch-ups. For example, teeing surfaces develop a crowned appearance after years of divots/sand topdressing, and laser-leveling significantly improves golf course aesthetics and playability. Likewise, bunkers often become contaminated with silt or clay through weathering and are eventually refurbished with good quality sand and supplemental drainage. Oftentimes, a new irrigation system is installed and projects such as these are conducted while the course is closed. In any case, these projects are necessary from time to time to protect the club's most valuable asset . . . the golf course.

Golfer frustration can develop following a renovation, caused by concerns such as damage from improper construction or unanticipated costs in time or money. There are other complaints that arise following a renovation that, from an outsider's point of view, seem rather minor. Perhaps these are due to the extended course closure or high costs of renovation, which create unfair expectations of perfection upon course opening. Or perhaps the project was improperly marketed to garner support from the members. In any case, unfair expectations often develop, and this article lists some of the more common complaints as well as ways to inform golfers of exactly what to anticipate.

COSMETIC SURGERY

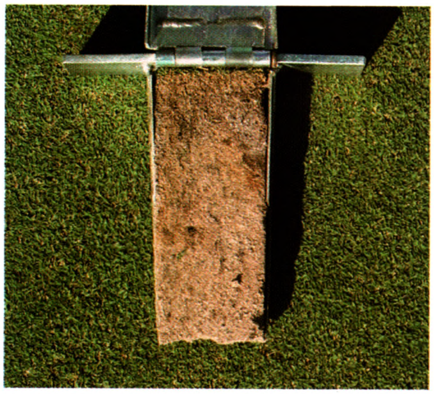
Patients who undergo cosmetic surgery are bruised and swollen for several months following surgery. The improvements, although long-lasting, are seldom immediately noticeable. This same phenomenon is true following most golf course renovations. Bunker sand requires time to settle and become firm. As a result, bunkers often are soft, and fried-egg lies are a common complaint for several months following renovation. Firmness is also an issue with putting greens. Unlike bunkers, however, putting greens usually are very firm during the first year or two following renovation. This can frustrate even the best golfers as the greens accept incoming shots poorly. It takes time to develop an appropriate "pad" of thatch and organic matter, and new putting greens remain firm until this occurs.

Surface irregularity is another common complaint of new putting greens immediately after renovation. This is especially troublesome on sprigged bermudagrass greens, as the stolons (runners) intermingle throughout the grow-in period and become dense. Turfgrass density improves as the grass acclimates to daily mowing; however, additional slicing, rolling, light verticutting, or sand topdressing are necessary to help smooth putting surfaces as they mature.

Newly renovated playing surfaces (greens, tees, fairways, and roughs) require time to mature and become dense. Thatch and organic matter are necessary for retaining water and nutrients, and having an adequate organic layer improves turfgrass recovery from stresses. Newly renovated areas often appear weaker or thinner than mature areas of the golf course until organic matter accumulates to appropriate levels.

There are also the unforeseen events that can occur during renovation. Heavy rainfall, which creates washouts on newly renovated areas and saturates the soil, delays construction as the areas must be recontoured when the soil dries. As a result, the golf course requires a longer maturation than if the weather had been ideal. Many golf courses reduce the likelihood of washouts by sodding tees, fairways, and roughs, especially on highly sloped areas. While the initial cost is high, sodding significantly reduces downtime caused by heavy rainfall. Having an experienced contractor is also very helpful when it comes to planning projects around the weather, as this is an issue they face regularly. Allowing a "cushion" of time for poor weather may be necessary, and it is important to express this up front to the golfers to minimize future complaints.

Another comparison that can be made between golf course renovation and cosmetic surgery is that renovations seldom create a completely different golf course. In the same manner that cosmetic surgery cannot make your wife look like Marilyn Monroe, renovation will not make your golf course look like Augusta National. Underneath the touch-ups, it is still the same golf course.



COMMUNICATE!

Good communication is necessary for developing fair expectations and a successful renovation. It is important to communicate the scope of the project as well as the amount of time necessary for construction and grow-in. As mentioned earlier, the renovated areas often require a season of maturation, and the conditioning of these areas changes significantly throughout the first year. It is important to communicate the time needed for maturation and the conditions to expect during that time.

Newly renovated putting greens lack an appropriate pad of thatch and organic matter. This results in greens that are very firm for the first one or two years. These soil profiles demonstrate the change in organic matter buildup over time.

There are different means of communicating to golfers, and the most obvious is through the golf club newsletter or presentations to the membership. If a golf course architect is involved with the renovation project, having the architect address the membership is an excellent means of communicating the scope and the time frame of construction and grow-in. It may be necessary to have several presentations prior to renovation and throughout various phases of the project, depending upon the size of the project, to keep members informed.

Scheduling a Turfgrass Advisory Service visit with a USGA agronomist is an excellent means of communicating with golfers. Agronomists visit many clubs throughout their region and can offer some insight into what to expect with the renovation and some important issues to consider. The USGA is a non-biased agency, and agronomists can often save the club time and money by offering impartial advice based on scientific research and knowledge gained from other golf courses. At the very minimum, agronomists can educate golfers of the pitfalls of renovation so they can develop fair expectations.

Hosting renovation tours of small groups of golfers is one of the best means of keeping them abreast of the renovation progress. These tours are generally only an hour or two in length and should be kept to a small number so that every question is easily answered. It is best to host tours periodically throughout the renovation to allow a greater number of golfers to attend. This allows golfers to see the progress of the project firsthand and gain a better perspective of the improvements. It also is an excellent educational vehicle for the daily operation of the golf course, as the superintendent can better explain how the renovation will improve golf course maintenance.

The internet also is an excellent means for communicating various projects to golfers. Computers are common in most homes or libraries throughout the United States, and golfers can receive instantaneous updates of projects like golf course renovations. Websites are especially helpful for seasonal members who travel back home during summer months and do not have the opportunity to see the golf course. A picture is worth a thousand words, and Web sites can store numerous digital images of the construction and grow-in so that golfers can know exactly what to expect upon the reopening of the golf course.

SUMMARY

Golf courses require an occasional "nip-and-tuck" from time to time to improve playability and aesthetics. Often these are not immediately noticeable but are improvements that will last for many years. The key to a successful renovation is to develop realistic expectations prior to the renovation and communicate them to the membership throughout the entire project. Contact your local USGA agronomist for some pre-surgery consultation before your next renovation.

TODD LOWE *is an agronomist in the USGA Green Section's Florida Region.*

After going to the trouble of renovating a golf course, it is imperative that adequate follow-up maintenance be sustained to maintain the integrity of the renovations.

CAN'T GET NO . . . SATISFACTION!

An informed membership will help you succeed with project work: managing golfers' expectations.

BY CHRIS CARSON

After a long winter and spring, four members of your Board arrive at the club in mid-June to play the newly renovated course. It's finally open! Considering the heavy assessment they've paid and the time they've waited, they are anticipating something special. As they play the first round of the year, however, their surprise mounts. They find bare areas in the rough that haven't been repaired, irrigation trenches that have been filled but not yet grassed, broken cart paths, soft sand in the new bunkers, and slow, bumpy greens.

Surely this can't be the result of all that work last fall and winter? They paid a lot for a new and improved golf course, and here on opening day it isn't perfect. In fact, it isn't even close!

MANAGE EXPECTATIONS

When Boards and superintendents undertake a project, they are responsible for more than the cost of the job, the quality of the work, and even the completion timetable. Perhaps more important is the management of golfer expectations.

In many ways, this can be the hardest task of all. Let's look at why. If a member restores a classic muscle car, he knows that if he does his homework and pays the right person enough money, he can own a perfect showpiece. The quality of the paint, the bodywork, and the mechanical parts will all be topnotch. That same person can be bitterly disappointed with the results of a golf course renovation if he has similar expectations of completed excellence.

The main reason is that a golf course project brings with it the additional

Whether using cool-season or warm-season grass, each needs adequate time to develop before the area receives foot or cart traffic. This bermudagrass putting green requires a grow-in period to allow the sprigs to knit together and become dense.

variables of time and weather. Even when a job is declared finished, it really isn't; it must mature, the scars must heal, the grass must adapt to its new location, sand must settle. These concerns will dissipate over time, but if golfer expectations were for perfection on opening day, there will be problems. The speed with which this all occurs depends on many things, but largely on the weather. Good weather can help keep a project on schedule, and unfavorable conditions can make it impossible.

It is important for all involved to know what the job is going to look like when complete, how long it will take to mature, and how the course will look and play during the construction period. In many cases, the main issue will be how a member's overall enjoyment of his course will be affected and for how long. If you address these issues up front, you will be shaping golfer expectations and the job will be better understood and accepted.

AVOID SURPRISES

The courses that have been most successful with projects are those that talk about these issues from the start. Though it is tempting when asking for money and support to paint a rosy picture of the end result, you will be doing a better job of selling — and have a better chance for long-term success — if you are straightforward about these concerns.

If your golf course has a newsletter, it is an excellent vehicle for outlining the proposed renovation. You can head off trouble by describing the improvements and offering a timetable for completion, but also cautioning golfers about specific limitations on play during the renovation period and after completion, until the changes have matured. Even a brief report, perhaps with a course diagram, on the club bulletin board would be helpful in eliminating confusion and misconceptions.

It's all about avoiding surprises. By handing out a timetable that shows when holes will be closed, how you will play the course during construction, how and when you will allow play, and how you will handle weather delays, you will be taking a big step toward managing the expectations of your golfers.

Certainly you'll want to talk about the long-term gain and the improvement to your course; it's only natural when selling a project to do that to generate enthusiasm. But if you also present a discussion of the possible pitfalls of the job and a realistic timetable for completion, you will be heading off trouble. Remember, it's not the immediate gain that you seek, but the long-term improvement of the golf course.

IDENTIFY THE PROBLEM

Let's look at several issues pertinent to a greens regrassing project. To say only

Although this is a new bunker, it is in need of additional drainage to eliminate worse problems down the road.

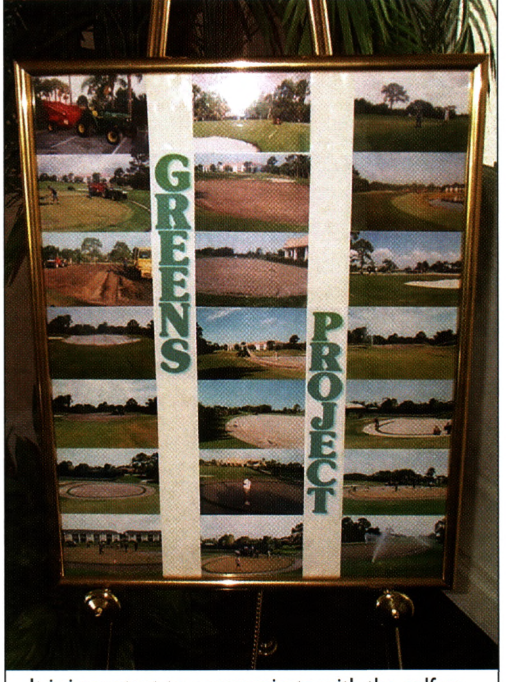
that you want the fast greens that new turf varieties can provide is not enough to justify or to identify the project. And to say that turf quality on your greens is poor and therefore they must be regrassed is insufficient, too, and a recipe for disaster. To succeed with this type of work, you must look at the entire problem and not just some of the symptoms.

For example, the reasons for poor green quality may be too many nearby trees, poor air movement, poorly drained soil, or some combination of the three. If a regrassing is performed without correcting the underlying causes of the turf problem, then early failure of the project and member displeasure will be guaranteed. If your greens are poor enough to require regrassing, there must be reasons why.

Identifying and solving the underlying causes for the original failure is your best chance toward succeeding with your new greens. If your golfers aren't happy with the quality of your greens now, how will they respond to an expensive project that doesn't work?

Your superintendent also must review his management program. Significant changes to the makeup of the greens and their surroundings might require changes to the way those greens are maintained. Certainly the fertility and water programs will need to be adjusted, but so, too, will cultural procedures like verticutting, topdressing, and aerification. Dramatic new mounding and bunkering may require more staff and different equipment to be maintained properly. This is an all too common surprise that can significantly impact the maintenance budget. The maintenance department must have the tools needed to complete these tasks, so if those tools aren't available, they should be included and budgeted for in the project planning.

Let's not forget the most difficult membership management problem of all: the golfers will almost certainly want to play the new greens before they are ready. It is critical that the greens be allowed to mature to the point where they can withstand the wear caused by play. Though golfers will be eager to play their new course and may become vocal about having to wait, the level of golfer unrest will be much higher if you open too early and cause damage to your new greens. If you've done a good job of communicating the need for patience going in, and if you've established up front a reasonable timetable for opening, you will be under much less pressure to open early.



It is important to communicate with the golfers throughout the renovation project to keep them apprised of the progress.

THE BUNKERS ARE NEW . . . WILL THEY ALWAYS LOOK THAT WAY?

Now let's take a look at another problem. In years past, sand bunkers were regarded as hazards, as areas to be avoided. In fact, the Rules of Golf still declare that they are hazards, but today's golfer, ironically, demands that they be groomed playing surfaces. The demand for consistent and perfect sand depths, raking, and firmness has caused today's superintendent to expend intense effort trying to satisfy his golfers. Most superintendents would agree that their crews spend much more time maintaining these hazards than they do the greens!

They are up against an impossible task. Sand settles and moves with rain, wind, and time; bunker edges get broken down by machine and foot traffic; debris and soil infiltrate the sand to change its consistency. Bunkers are constantly changing, and what used to be viewed as part of the charm and challenge of the game is now viewed as poor maintenance.

Golfer expectations are so high that today's bunker is a much different feature than it was in the past. That's important when it comes to defining what you want your bunker renovation project to achieve. While you may have great success in restoring interest, character, and challenge, you will not — and over the long term cannot — achieve perfectly consistent bunkers. Golfers will have a greater appreciation for the dynamic nature of bunkers if you take the time to educate them prior to renovation. If they have an understanding about the changes brought by time to bunkers, they may become less demanding — and more satisfied — with the end results of the work.

GIVE IT TIME

It seems contradictory, but in general, new course construction will both improve over time through turf maturity . . . and deteriorate through the natural aging process! If the Board and golfers understand this aging process and the superintendent has a plan to minimize its impact, then the chances for success with a renovation project will be good. If all involved have planned well, have communicated throughout the work, and have managed the construction properly, the transition from work zone to enjoyable golf course will be smooth . . . and the golfership will be satisfied.

CHRIS CARSON *is the superintendent of Echo Lake C.C. in Westfield, N.J.*

Zoysiagrass, Salt Glands, and Salt Tolerance

Observing the density of salt glands may make selecting for salt-tolerant grasses a lot easier.

BY K. B. MARCUM, G. WESS, D. T. RAY, AND M. C. ENGELKE

Water shortages throughout the United States are resulting from rapid urbanization and drought. In the western U.S., limited water supplies have caused some municipalities to implement xeriscape programs. With 50% or more of total urban water consumption being utilized for landscape irrigation in western states, many municipalities are requiring use of recycled or other saline secondary water sources for turf landscapes.

Though there is increasing need for improved salt-tolerant turfgrass cultivars, breeding progress has been limited. Turf breeders typically need to select among hundreds or thousands of progeny to come up with an improved cultivar. Selection for salt tolerance among so many progeny is difficult, time-consuming, and expensive. Therefore, accurate and efficient salt-tolerance screening tools are needed to expedite turf cultivar development. These tools may be morphological or physiological markers that can be used to predict salt tolerance.

SALT GLANDS — A SALT-TOLERANCE MECHANISM IN TURF

Most plants, including grasses, exclude saline ions (sodium, chloride, etc.) from shoots and leaves to minimize their toxic effects. Saline ion exclusion from shoots has been associated with salt tolerance among grasses in a number of studies and is a major physiological process associated with salt tolerance.

Salt glands are found in a number of warm-season (C4) grasses, including bermudagrass, zoysiagrass, buffalograss, saltgrass (*Distichlis spicata* var. *stricta*), dropseeds (*Sporobolus spp.*), gramagrasses (*Bouteloua spp.*), and curly mesquite (*Hilaria belangeri*). Salt glands, which are actually miniature ion pumps, secrete salt from leaves and can be a major means of excluding saline ions in salt-tolerant grasses. In fact, in salt-tolerant grasses having active glands, secreted salt crystals can be seen on leaves of plants growing in salty soils.

Salt glands, which are modified leaf microhairs (trichomes), are microscopic two-celled structures that lie flat on the leaf surface in rows parallel to stomates. Unlike internal physiological plant markers, salt glands are externally visible and morphological. They can be easily observed on grass leaves. The goal of this research was to determine if salt gland density can be used to predict turfgrass salt tolerance, and if they can be used as an effective salt-tolerance selection tool by turfgrass breeders.

THE EXPERIMENT — SALT TOLERANCE

Fifteen zoysiagrasses (Japanese lawngrass, *Zoysia japonica*) were tested for salinity tolerance using a solution culture-hydroponics growing system. This system allows precise control of salinity levels and can accurately determine differences in salt tolerance among turfgrass varieties. It also allows monitoring of both root and shoot responses to salinity. To compare salt tolerance among entries, changes in shoot growth (clipping weight), root growth, and visual quality (percent green leaf area) were observed at six different salinity levels over a growth period of several months.

Throughout the experiment, grasses were clipped twice per week at one inch. As salinity increased, leaf clipping weight decreased linearly. The relative shoot growth and visual quality (percent green leaf area) at high salinity were used to indicate the relative salinity tolerance of varieties. The most salt tolerant varieties were El Toro and Palisades, and the least tolerant were Sunrise, K162, JS-23, and K157.

SALT GLANDS — A POTENTIAL TOOL FOR TURFGRASS BREEDING

Salt gland densities were determined for all entries, growing under both salt-free (control) and saline conditions. Densities were determined using a light microscope, with 120 observations taken on each zoysiagrass variety (each observation was a gland count).

It had been previously found that salt tolerance in zoysiagrasses and in general among Chloridoid warm-season grasses (bermudagrass, buffalograss, zoysiagrass, gramagrasses, *Sporobolus*, and saltgrass) was related to the amount of salt that the salt glands were able to secrete (the amount pumped out of the leaves).

In addition, results of this study show that salt tolerance and salt gland activity are related to the actual density of salt glands on the leaves, or the number of glands per unit of leaf area. There is a positive correlation with both leaf salt gland density and salt tolerance. In other words, as leaf salt gland density increases, so does salt tolerance.

If salt gland density is to be a valuable screening tool for turfgrass breeders, it must be genetically, not environmentally, controlled. In other words, salt gland density must be highly heritable (passed from parent to offspring). To determine this, we measured salt gland density of varieties growing both in a saline environment and in a salt-free environment.

It was found that salt glands are not induced by salt stress, i.e., within a variety there was no difference in gland density between a plant grown in saline conditions and one grown in salt-free conditions. In other words, the grasses are "born" with a certain density, depending on their genetics. Averaged across all genotypes and within a genotype, there was less than a 1% difference between control (non-stressed) and salt-stressed grasses, indicating a very high heritability for this trait.

Table I
Predicting salt tolerance of zoysiagrasses, based on the relative clipping weight and on visual quality (percent green leaf area) at high salinity. Grasses are listed from highest to lowest salt tolerance. Shoot growth and green leaf area variables were highly correlated ($R^2 = 0.73$) and are equally effective in predicting salinity tolerance.

Grass	Relative Clipping Wt.	% Green Leaf Area
El Toro	83	52
Palisades	68	45
Meyer	56	20
J3-2	55	48
P58	55	47
Belair	54	54
Crowne	52	24
K12	23	9
J21	20	6
J94-5	19	3
Korean Common	12	2
K16	20	0
Sunrise	0	0
JS-23	0	0
K157	0	0

A greenhouse hydroponic system was used to investigate turfgrass salinity tolerance. This system allows for precise control of salinity levels, and both shoot and root responses to salinity can be monitored.

Salt gland density on grasses grown in salt-free conditions predicted salinity tolerance as well as plants grown under saline conditions. This is the first report of a morphological (visual) trait that can be used to predict salt tolerance of grasses. Salt gland density is an innate, genetically controlled, heritable trait that does not require environmental stress conditions to express it.

Accurately screening hundreds or thousands of breeding selections for salt tolerance is difficult and expensive. Salt gland density is a much easier screening procedure that could expedite selection of salt-tolerant grasses in that the breeder need only measure salt gland density on leaves of plants growing under regular (non-salt) conditions.

LITERATURE CITED

1. Access, newsletter of the American Water Works Association, May 2003, Vol. 2, Issue 2, pp. 1, 3.

2. Amarasinghe, V., and L. Watson. 1989. Variation in salt secretory activity of microhairs in grasses. *Aust. J. Plant Physiol.* 16:219-229.

3. Arizona Department of Water Resources. 1995. Modifications to the second management plan: 1990-2000. Phoenix, Ariz., 74 pp.

4. California State Water Resources Control Board. 1993. Porter-Cologne Act provisions on reasonableness and reclamation promotion. California Water Code, Section 13552-13577.

5. El Paso Water Utilities Public Service Board. 1992. El Paso Water Resource Management Plan, Nov.

6. Fahn, A. 1988. Secretory tissues in vascular plants. *New Phytol.* 108:229-257.

7. Gorham, J., R. G. Wyn Jones, and E. McDonnell. 1985. Some mechanisms of salt tolerance in crop plants. *Plant Soil* 89:15-40.

8. Hannon, N. J., and H. N. Barber. 1972. The mechanism of salt tolerance in naturally selected populations of grasses. *Search* 3:259-260.

9. Johnson, R. C. 1991. Salinity resistance, water relations, and salt content of crested and tall wheatgrass accessions. *Crop Sci.* 31:730-734.

10. Kjelgren, R., L. Rupp, and D. Kilgren. 2000. Water conservation in urban landscapes. *HortSci.* 35(6):1037-1040.

11. Marcum, K. B. 2001. Growth and physiological adaptations of grasses to salinity stress. Pages 623-636. *In:* M. Pessarakli (ed.), Handbook of Plant and Crop Physiology, Marcel Dekker, Inc., N.Y.

12. Marcum, K. B. 1999. Salinity tolerance mechanisms of grasses in the subfamily Chloridoideae. *Crop Sci.* 39:1153-1160.

13. Marcum, K. B., and C. L. Murdoch. 1990. Salt glands in the Zoysieae. *Ann. Bot.* 66:17.

14. Marcum, K. B., S. J. Anderson, and M. C. Engelke. 1998. Salt gland ion secretion: A salinity-tolerance mechanism among five zoysiagrass species. *Crop Sci.* 38:806-810.

15. Naidoo, G., and Y. Naidoo. 1998. Salt tolerance in *Sporobolus virginicus*: The importance of ion relations and salt secretion. *Flora-Jena* 193:337-344.

16. Smith, C. S., and R. St. Hilaire. 1999. Xeriscaping in the urban environment. *New Mexico J. Sci.* 38:241-250.

17. Wu, L., and H. Lin. 1994. Salt tolerance and salt uptake in diploid and polyploid buffalograss (*Buchloe dactyloides*). *J. Plant Nutr.* 17:1905-1928.

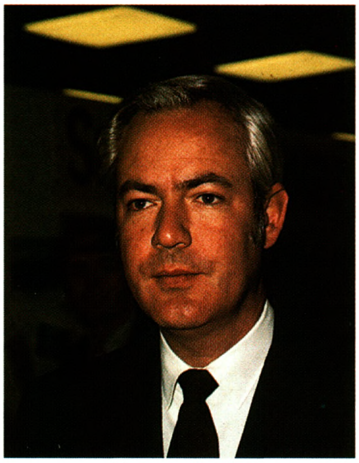
18. Yeo, A. R. 1983. Salinity resistance: Physiologies and prices. *Physiol. Plant.* 58:214-222.

K. B. MARCUM, PH.D., *is an assistant professor, Department of Applied Biological Sciences, University of Arizona*; G. WESS *is a graduate student*; D. T. RAY, PH.D., *is a professor, Plant Genetics, Department of Plant Sciences, University of Arizona*; M. C. ENGELKE, PH.D., *is a professor, Texas A&M University Research and Extension Center, Dallas.*

A GLIMPSE AT THE T.A.S. OF THE SIXTIES

Memories of the early days by a USGA Green Section agronomist from 1962 to 1976.

BY HOLMAN GRIFFIN



Holman Griffin

In the sixties it might have been a record that I spent 206 nights on the road in one year. I could not even reply to the census, which was slipped under the motel door, as a resident of my own home. Most of us Green Section agronomists were flying about 100,000 miles a year, and when on the ground it was not unusual to drive 1,600 miles a week. There were some close calls, but in 15 years on the road I never had to spend the night in the car, even once.

We were going to run Monty Moncrief, then Green Section Southeastern Director, for President because he was so well liked. Monty became my boss in 1968 and at my first meeting working with him he said, "Holman, you have been with the Green Section almost as long as I have. Now, I am going to travel these states and you are going to travel those. If you can't handle it, you are in trouble. Now, let's go play golf."

We all revered and respected Dr. Marvin Ferguson as our leader and felt he had a handle on the answer to any turf question as much as any man alive. Marvin began with the Green Section in the fifties, and he and Joe Dey (USGA Executive Director from 1934 to 1969) discussed whether our automobiles should have radios and air-conditioning. You'd think that should have been obvious!

One year I studied the possibility of all agronomists becoming pilots and traveling the country in our own airplanes. The conclusion was that it would be feasible only if we parachuted a man out and picked him up on the return. The plan for the year, which consisted primarily of a budget total for each Director, was discussed behind the potted palms in the Biltmore Hotel at the USGA Annual Meeting in New York for about five minutes each year. So much for input! My starting salary was $5,500 a year, and when I reached $24,000 annually, the world was my oyster.

I can only look back on those days as a wonderful learning experience and a wonderful life experience. I was privileged to visit and travel many times with some of the pioneers of turf, including Eb Steiniger, O. J. Noer, Tom Mascaro, Joe Duich, Fred Grau, Bill Bengeyfield, Al Radko, R. C. Potts, Jim Latham, Charlie Wilson, Jim Watson, and so many others.

Congratulations to the past and present Green Section agronomists on 50 years of service, and I offer some words from Monty Moncrief as sage advice for the future: "Stay on the side of the grass."

A TWOSOME'S TALE OF TWO TIMES

The evolution of the Green Section and the Turf Advisory Service from an inside perspective.

BY LOIS AND JIM LATHAM

Lois and Jim Latham

We served the Green Section twice: 1957-1960 and 1984-1994. These times are remembered as the pre- and post-television eras, or when the USGA just *existed*, and later, after it became a leading participant in the sports world. In the pre- years, income came only from dues and admissions to USGA championships. Joe Dey, USGA Executive Director, ran a very tight ship in every respect, with few employees and a low operating budget. The post- years were more amenable, with more attention given to streamlined operations, wider ranges of activity, and greater educational responsibilities.

Lois: I came into the picture when the Southeastern office was moved from Tifton, Georgia, to Beltsville, Maryland, after B. P. Robinson resigned in 1956. The legendary Fred Williams, whose tenure (1922-1959) dated from John Montieth's time, had become the secretary for both the Mid-Atlantic and the Southeastern offices, and he simply couldn't cope with Jim's southern lingo on imperfect, mail-in disk records made while driving the pre-interstate roads. I helped Fred, part time, with Jim's reports and expense accounts, and when the midsummer reports came in hot and heavy. In those days, the agronomist made two visits to each subscriber each year, and although the reports were short, the work load became a chore.

Jim: The mail-ins were mandatory, since the Southeastern Region amounted to seven states from North Carolina to Florida to Tennessee. I had to drive across D.C. and the state of Virginia to go to work! By sharing an office in the USDA building in Beltsville, the USGA saved rent and a secretary's salary. Coming home for weekends was out of the question, as was the expense of using airlines. And leaving on Monday left little work time that week. One year I was out of town 176 days.

Lois: After recounting the distance and communications problem (calling home frequently was frowned upon when the long-distance bills came in), Mr. Dey gave permission for us to seek another location within the Southeast, preferably at a university or research facility (i.e., rent free!). George King, director of the Georgia Experiment Stations, found a place for us on the third floor of old Conner Hall on the University of Georgia campus in Athens.

It was not exactly an office; it was a laboratory room. We had no office furniture and neither did the university. Jim had a lab table to work on and I had an old typewriter desk, but *no* typewriter. I brought in my own typewriter, but working only half time I sometimes needed it at home. Carrying that heavy manual machine around became a real chore. A request to Joe Dey to buy a typewriter was denied, so I inquired about rentals. I found that the monthly rental was $6.00, so I began billing the USGA $6.00 a month. After the second month, we received a note from Mr. Dey to buy a *used* typewriter. Frugality at its finest. The greatest help was a phone line connected to the Horticulture Department, so at least our phone was covered at all times.

Jim: Green Section travelers have never lived high on the hog. In the fifties we ate and slept on $18.00 a day. The two Holiday Inns that existed then were too expensive. Joe Dey personally checked all expense accounts. He also spot-checked reports to make sure we used good English. The cars we drove were minimum transportation, but I was more fortunate than most. In 1957 I bought a mid-range Chevy equipped with a radio, automatic transmission, and nothing else. I once got a quail in my lap — feathers, blood, and all — while driving with the window vent facing forward to bring in as much air movement as possible. The next car, a finned beauty Plymouth, had air conditioning because the dealer (a Green Section committeeman) didn't want to see us coming to his golf course looking like a limp dishrag.

Lois: Sometimes the fiscal reconciliation was slow, between the time the local bills were submitted to Golf House and the time we received their check. More than once, our bank called to report overdrafts in the Green Section account. I just told them to take the amount needed out of our personal account and we would then reimburse ourselves when the USGA check came in. Imagine — the Lathams bankrolling the USGA! There were a few panic attacks, since salaries ran parallel to expense levels.

Jim: There was a substantial dislike of the USGA by superintendents at golf courses that had hosted the Open. There was no way, they felt, that bentgrass would survive a 3/16-inch cut in late June (the normal mowing height was 1/4 inch or perhaps higher), because the greens always died in July or August. More than one superintendent told me that the two best ways to be fired were to be president of the GCSAA and to be at a course that hosted the Open. I knew a few who had moved south after bad experiences upcountry. Incidentally, many superintendents of that day worked on northern courses during the golf season and then moved south to run the winter clubs during that season. Those were the kinder, gentler days.

We left the Green Section in 1960 to follow other turf work — at a slightly better salary. I was told that the other agronomists were glad to see me go, since all of them got significant raises — to above that for which I left. So went the world.

Lois: Returning to the Green Section after an absence of 25 years (through the grace of Bill Bengeyfield and Stan Zontek) was a great experience. All we had to do was move the office equipment from Crystal Lake, Illinois, to Milwaukee, Wisconsin. But we had furnishings this time — an electric typewriter, chairs, and desks. No personal move was involved. The expense reimbursement checks came in on time, but they were subject to the same scrutiny. Getting into computers is another story for another time.

Jim: The post-TV USGA has allowed the new order Green Section to be more conscious of creature comfort, but the work is no less intense — probably more so, since golf courses are now subject to more demands and greater scrutiny. In the fifties, much of the reports to subscribers dealt with rates and dates of application of any consumable (like lead arsenate, sodium arsenite, potassium cyanate, mercury compounds — and Italian ryegrass) used on golf courses. Today, the label on any chemical is the law, and knowledge of many governmental regulations is mandatory. The other components of reports are essentially the same, except for the much more intensive management given golf courses today. And the preparation of championship courses today begins much earlier than it did in the fifties, so the superintendents are much better prepared for that stress.

Lois: Nepotism has not been a dirty word in Green Section offices, because the work must be done within certain time frames, and if it isn't, everyone involved will hear from the subscribers and/or the national director. That includes turf advisory reports, articles for publication, conference notes, etc. Today, telephone and e-mail are a way of doing business that has simplified operations considerably. That's where the practicality of having spouses in the know about office matters comes in. Communication after business hours can accomplish many things, including her knowing where the old man is and what he is up to.

A neighbor once asked me how our marriage had held up for so long since Jim had spent so much time away from home. I told her that she had just answered the question (we celebrated our 52nd anniversary in 2003).

JIM AND LOIS LATHAM *now reside in Deltona, Florida.*

Much To Do About Wetlands

The management of wetlands — a primer.

BY JEAN MACKAY

As a game played in a natural setting, golf presents far more than a recreational outlet for golfers. Golf courses are diverse landscapes that can be managed to showcase regional plant communities and wildlife habitats — including some of our most valuable: *wetlands*.

Yet, many superintendents consider wetland management a challenge — in no small part because of regulatory concerns and requirements. Questions abound: Is the wetland on my course a regulated wetland? What regulations apply? When is it best to just leave a wetland alone and when is it best to actively manage it?

This article answers some of these basic questions and provides case examples from golf courses that are managing wetlands successfully and with confidence.

HOW ARE WETLANDS DELINEATED?

When a golf course construction or renovation project may impact a wetland, wetland consultants are generally called in to define the wetland's boundaries. Wetland delineation is complicated by the fact that wetland boundaries are often highly variable, since water levels fluctuate from year to year. Rather than having distinct beginning and ending points, wetlands often transition gradually into uplands as water levels, soil saturation, drainage, and topography change. Experts use a variety of methods to identify and mark a wetland boundary, including site surveys, aerial photography, GIS maps, soil surveys, and national wetland inventory maps.

On-site observation primarily includes a survey of three things: vegetation, soils, and hydrology.

Vegetation: Wetland consultants look at the types of plants growing on site to delineate the wetland boundary. Plants that are highly adapted to saturated soils and wet conditions are called *hydrophytic*. Consultants identify plants that are almost always found in wetlands (*obligate wetland plants*), as well as those that occur in wetlands most of the time (*facultative wetland plants*). Wetlands generally have some combination of obligate and facultative plant species, depending on the site's hydrology, soils, and topography.

Soils: Consultants use a soil probe to take soil samples in various locations in and around the wetland. They look for hydric soils that developed in conditions where soil oxygen is or was limited by the presence of water for long periods of the growing season. For instance, hydric soils may be gray or black in

A variety of emergent and floating plants in a typical wetland environment at Silver Lake C.C. (Orland Park, Illinois) illustrates how wetland vegetation changes as the wetland gets deeper. Depth of the water level is a key consideration when choosing plants to add to a golf course pond, lake, or wetland shoreline.

Many golf courses have seasonally wet areas, intermittent streams, or small wetlands, such as this one at Big Canoe Golf Course (Big Canoe, Georgia). Preservation is the preferred method of managing wetlands.

color, indicating that the iron content has been leached out. Hydric soils usually contain predominantly decomposed plant material (peat or muck) and may have a sulfidic odor.

Hydrology: Field observations include the depth of surface water, depth to saturated soils, drainage patterns, water marks on vegetation, drift lines, and sediment deposits. These wetland indicators help wetland experts determine high and low water flows.

HOW DO WETLAND REGULATIONS APPLY TO GOLF COURSES?

According to the United States Army Corps of Engineers, the primary governmental agency charged with regulating activities in the nation's waters, Section 404 of the Clean Water Act (33 U.S.C. 1344) prohibits the discharge of dredged or fill material into waters of the United States without a permit from the Corps of Engineers. The phrase "waters of the United States" includes navigable waters, but it also includes non-navigable water bodies, perennial and intermittent streams, wetlands, mudflats, and ponds.

Typical activities, although not entirely inclusive, that would require Section 404 permits are depositing fill or dredged material in waters of the U.S. for such things as:

- Utility installations, stream relocations, or culverting.
- Site development fills for residential, commercial, or recreational developments.
- Construction of revetments, groins, breakwaters, levees, dams, dikes, and weirs.
- Placement of riprap and road fills.

Because wetland regulations are site and state specific, golf course personnel should contact local authorities when golf course improvement, renovation, or construction projects may impact water bodies.

WHEN SHOULD MY GOLF COURSE APPLY FOR A CORPS PERMIT?

According to the U.S. Army Corps of Engineers:

Permits are required by federal law for almost all projects that involve work in a water of the United States. You should apply for a Corps permit as early as possible during the conceptual stage of a project, while there is still some flexibility in the project design. Since it may take a number of months to process a routine application involving public notice, it is prudent not to wait until permits are obtained from all local and state agencies before going to the Corps.

If you are unsure whether your project requires a permit, contact your nearest Corps office. Performing unauthorized work in waters of the United States or failure to comply with the terms of a valid permit can have serious consequences. Golf courses may face stiff penalties, including fines and requirements to restore the area.

In cooperation with the USGA Wildlife Links Program, Audubon International is helping to produce a practical manual on managing wetlands on golf courses. Audubon Cooperative Sanctuary Program members have submitted numerous case studies, which can be found at:

www.audubonintl.org/esource

Click on "wetlands on golf courses."

JEAN MACKAY *serves as director of educational services for Audubon International. She can be reached at jmackay@audubonintl.org.*

Mike Kenna was joined by his family and friends when he received the 2003 Distinguished Alumni Award. Left to right: Patrick Kenna, Irene and John Kenna, Charlie Kenna, Susan and Mike Kenna, and Dr. Kent Kurtz.

KENNA RECEIVES DISTINGUISHED ALUMNI AWARD

Michael P. Kenna, Ph.D., USGA Green Section Research Director, was presented the 2003 Distinguished Alumni Award from the Cal Poly Pomona Alumni Association on June 6, 2003. Dr. Wayne R. Bidlack, dean of the Cal Poly School of Agriculture, was on hand to present the award that recognizes professional achievement, community service, and service to Cal Poly Pomona. Dr. Kenna was nominated by Dr. Kent Kurtz, professor of ornamental horticulture and turfgrass management in the Cal Poly Horticulture/Plant and Soil Science Department.

A 1979 Cal Poly Pomona ornamental horticulture graduate, Kenna has been the USGA Green Section director of research for the past 13 years. During this time, he has been responsible for overseeing the distribution of more than $14 million in grants to 180 research projects at more than 40 universities and institutions through the USGA Turfgrass and Environmental Research Program.

"There is a sense of hope that careful and steady work will produce better plants for all of us to use in the future, whether in traditional agriculture or in our urban landscapes," Kenna says. "I enjoy my job, the interaction with university faculty and graduate students through USGA-sponsored programs, and the opportunity to direct a program that is making progress with regard to resource management and environmental issues."

STATEMENT OF OWNERSHIP, MANAGEMENT, AND CIRCULATION

1. Title of Publication — USGA GREEN SECTION RECORD. 3. Date of Filing — September 8, 2003. 4. Frequency of issue — Bimonthly: January/February, March/April, May/June, July/August, September/October, and November/December. 5. Number of issues published annually — 6. 6. Annual Subscription Price — $18.00. 7. Complete mailing address of known office of publication — United States Golf Association (USGA), Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. 8. Complete mailing address of the headquarters or general business office of the publisher — USGA, Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. 9. Names and addresses of Publisher, Editor, and Managing Editor: Publisher — USGA, Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. Editor — James T. Snow, USGA, Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. Managing Editor — James T. Snow, USGA, Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. 10. Owner (If the publication is owned by a corporation, give the name and address of the corporation, immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address, as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.) — United States Golf Association (USGA), Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. 12. For completion by nonprofit organizations authorized to mail at nonprofit rates — The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes has not changed during preceding 12 months. 13. Publication title — USGA Green Section Record. 14. Issue Date for Circulation Data Below — Sept./Oct. 2003. 15. Extent and nature of circulation —

	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies *(Net press run)*	18,550	18,500
b.1. Paid/Requested Outside-County Mail Subscriptions Stated on Form 3541	17,100	17,125
b.2. Paid In-County Subscriptions Stated on Form 3541	0	0
b.3. Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Non-USPS Paid Distribution	0	0
b.4. Other Classes Mailed Through the USPS	0	0
c. Total Paid and/or Requested Circulation	17,100	17,125
d. Free Distribution by Mail *(Samples, complimentary, and other free)*		
d.1. Outside-County as Stated on Form 3541	850	815
d.2. In-County as Stated on Form 3541	0	0
d.3. Other Classes Mailed Through the USPS	0	0
e. Free Distribution Outside the Mail *(Carriers or other means)*	315	295
f. Total Free Distribution	1,165	1,110
g. Total Distribution	18,265	18,235
h. Copies Not Distributed	285	265
i. Total	18,550	18,500
j. Percent Paid and/or Requested Circulation	93.6%	93.9%

I certify that the statements made by me above are correct and complete.

JAMES T. SNOW, Editor

Maybe It's Time for a Change

Sometimes you just have to bite the bullet.

BY PAUL H. VERMEULEN

With each passing year, a growing number of golf course superintendents are finding it increasingly difficult to manage greens established with older turfgrasses. The driving force behind this trend can be traced back to the rallying cry for higher Stimpmeter readings that necessitate mowing greens at ever lower cutting heights. To put things in perspective, superintendents have all but given up measuring cutting height on a scale of common fractions, e.g. $\frac{9}{64}$ of an inch, because it is no longer accurate enough for maintenance programs that focus on microscopic adjustments of 5 thousands of an inch.

Cutting height plays a pivotal role in putting green management as it can be used to increase the Stimpmeter reading by influencing the harvest of green tissue. Since green tissue contains the photosynthetic machinery that turns water and carbon dioxide into life-sustaining carbohydrates, however, lowering the cutting height can literally cause the turf to slowly starve to death. The breaking point between satisfying golfers' craving for fast greens and mowing the turf to the brink of extinction is different for each course. That being said, you know you are close to this point when weak fungal pathogens, such as anthracnose, become unusually difficult to control and thinning of the turf allows moss to become a permanent resident in the putting surface.

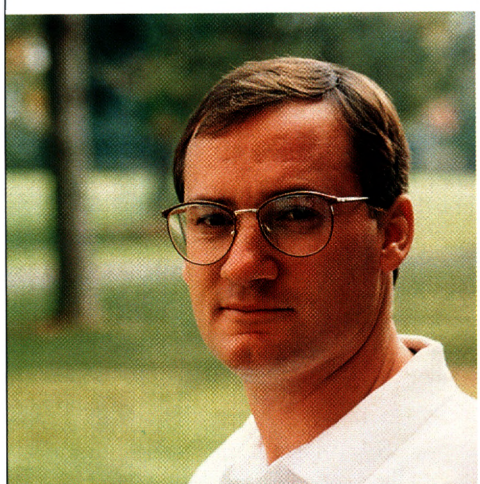
Do any of these problems sound disturbingly familiar? Perhaps they should, since they are all common themes of the Regional Updates on the Green Section's website (www.usga.org/green). When rotating fungicide applications and drenching moss with everything under the kitchen sink does not take care of the greens' problems anymore, everybody wants to know what to do next. Agronomically, the best course of action is to raise the cutting height, give the turf a pinch of extra fertilizer, and turn a deaf ear to golfers when they comment about slow greens. Unfortunately, this is not the solution golfers are really seeking, and it is certainly not the kind of message a superintendent looks forward to passing along to a green chairman.

In high-pressure situations, raising the cutting height and slowing down the speed of the greens is, at best, a temporary solution. The simple reason is that there are always going to be courses with fast greens that golfers are going to use as a convenient comparison to put pressure on the superintendent, either real or perceived, to lower the cutting height again. Not fair? Absolutely not, but that is the kind of rotten hand many superintendents have been dealt.

If playing a losing hand year after year is no longer acceptable, then maybe it's time for a change. To start, let's accept the premise that golfers may not be completely out of line when they ask for better year-round putting conditions. It's radical, to be sure, but if they truly want something better, how about proposing a new stand of turf?

Assuming that the old turf on the greens has genetic limitations that cannot be overcome via more aerification, more pesticides, and more man-hours, one way to improve putting conditions is to fumigate and replant with a turfgrass variety or varieties specifically bred to be maintained at a lower cutting height. In the last decade, turfgrass breeders have worked diligently to produce a plethora of new warm- and cool-season varieties that have greater heat tolerance, better disease resistance, finer texture, and deeper root development. Combined, these attributes make it possible to maintain greens at 0.125 of an inch throughout the entire golfing season in many areas of the country.

Replanting greens with an improved variety or varieties is not easy, nor can it be done in the blink of an eye, but Rome was not built in a day, either. If golfers truly want better putting conditions and they are willing to foot the bill and give up the course for a season, change can really be a worthwhile endeavor.



PAUL VERMEULEN *is the director of the Mid-Continent Region. In the last few years, he has worked with several courses that have replanted greens to the overwhelming satisfaction of golfers.*

USGA

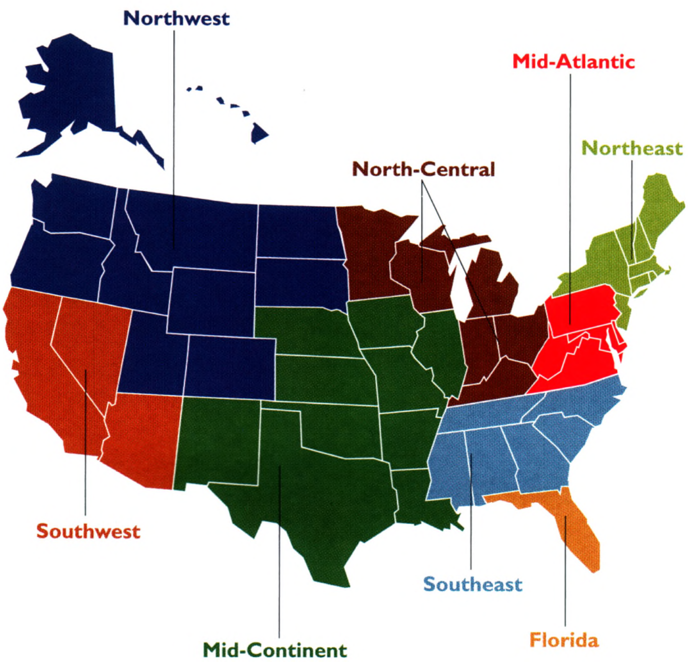
GREEN SECTION NATIONAL OFFICES

United States Golf Association, Golf House
P.O. Box 708
Far Hills, NJ 07931
(908) 234-2300 Fax (908) 781-1736
James T. Snow, *National Director*
jsnow@usga.org
Kimberly S. Erusha, Ph.D.,
Director of Education
kerusha@usga.org

Green Section Research
P.O. Box 2227
Stillwater, OK 74076
(405) 743-3900 Fax (405) 743-3910
Michael P. Kenna, Ph.D., *Director*
mkenna@usga.org

904 Highland Drive
Lawrence, KS 66044
785-832-2300
Jeff Nus, Ph.D., *Manager*
jnus@usga.org

Construction Education Program
720 Wooded Crest
Waco, TX 76712
(254) 776-0765 Fax (254) 776-0227
James F. Moore, *Director*
jmoore@usga.org



REGIONAL OFFICES

●Northeast Region
David A. Oatis, *Director*
doatis@usga.org
James H. Baird, Ph.D., *Agronomist*
jbaird@usga.org
P.O. Box 4717
Easton, PA 18043
(610) 515-1660 Fax (610) 515-1663

James E. Skorulski, *Senior Agronomist*
jskorulski@usga.org
1500 North Main Street
Palmer, MA 01069
(413) 283-2237 Fax (413) 283-7741

●Mid-Atlantic Region
Stanley J. Zontek, *Director*
szontek@usga.org
Darin S. Bevard, *Agronomist*
dbevard@usga.org
P.O. Box 2105
West Chester, PA 19380-0086
(610) 696-4747 Fax (610) 696-4810

Keith A. Happ, *Senior Agronomist*
khapp@usga.org
Manor Oak One, Suite 410,
1910 Cochran Road
Pittsburgh, PA 15220
(412) 341-5922 Fax (412) 341-5954

●Southeast Region
Patrick M. O'Brien, *Director*
patobrien@usga.org
P.O. Box 95
Griffin, GA 30224-0095
(770) 229-8125 Fax (770) 229-5974

Christopher E. Hartwiger, *Agronomist*
chartwiger@usga.org
1097 Highlands Drive
Birmingham, AL 35244
(205) 444-5079 Fax (205) 444-9561

●Florida Region
John H. Foy, *Director*
jfoy@usga.org
P.O. Box 1087
Hobe Sound, FL 33475-1087
(772) 546-2620 Fax (772) 546-4653

Todd Lowe, *Agronomist*
tlowe@usga.org
127 Naomi Place
Rotonda West, FL 33947
(941) 828-2625 Fax (941) 828-2629

●Mid-Continent Region
Paul H. Vermeulen, *Director*
pvermeulen@usga.org
9 River Valley Ranch
White Heath, IL 61884
(217) 687-4424 Fax (217) 687-4333

Charles "Bud" White, *Senior Agronomist*
budwhite@usga.org
2601 Green Oak Drive
Carrollton, TX 75010
(972) 662-1138 Fax (972) 662-1168

●North-Central Region
Robert A. Brame, *Director*
bobbrame@usga.org
P.O. Box 15249
Covington, KY 41015-0249
(859) 356-3272 Fax (859) 356-1847

Robert C. Vavrek, Jr., *Senior Agronomist*
rvavrek@usga.org
P.O. Box 5069
Elm Grove, WI 53122
(262) 797-8743 Fax (262) 797-8838

●Northwest Region
Larry W. Gilhuly, *Director*
lgilhuly@usga.org
5610 Old Stump Drive N.W.,
Gig Harbor, WA 98332
(253) 858-2266 Fax (253) 857-6698

Matthew C. Nelson, *Agronomist*
mnelson@usga.org
P.O. Box 5844
Twin Falls, ID 83303
(208) 732-0280 Fax (208) 732-0282

●Southwest Region
Patrick J. Gross, *Director*
pgross@usga.org
David Wienecke, *Agronomist*
dwienecke@usga.org
505 North Tustin Avenue, Suite 121
Santa Ana, CA 92705
(714) 542-5766 Fax (714) 542-5777

Subscriptions $18 a year, Canada/Mexico $21 a year, and international $33 a year (air mail).

Subscriptions, articles, photographs, and correspondence relevant to published material should be addressed to: United States Golf Association, Green Section, Golf House, P.O. Box 708, Far Hills, NJ 07931.

Green Section Record (ISSN 0041-5502) is published six times a year in January, March, May, July, September, and November by the United States Golf Association®, Golf House, Far Hills, NJ 07931.

Postmaster: Address service requested — USGA Green Section Record, P.O. Box 708, Golf House, Far Hills, NJ 07931-0708.

Periodicals postage paid at Far Hills, NJ, and other locations. Office of Publication, Golf House, Far Hills, NJ 07931.

Printed on recycled paper

Turf *Twisters*

Q: I am the Green Chairman at our course, and the superintendent and I are having a disagreement concerning aeration. Since we are in a cold region where golf is played from late March to early November, I say we only need to aerify once a year. Our superintendent says twice with large tines is necessary. Is the spring aeration needed when we have no play during the winter? (Washington)

A: Aeration of greens generally is done to relieve compaction from traffic, provide avenues of sand through the surface to enhance drainage, and to assist in organic removal. While the specifics of your greens and site are not known, I would have to side with you since there is no growth or play during the winter months. Large-tine aeration in the fall will assist with winter drainage, but

spring aeration would seem unnecessary. Perhaps a compromise would be the use of very small tines in the spring, as this would also be a benefit for your players who would not have to endure a three- or four-week period of regrowth following the aeration process.

Q: How can we find past rain and snowfall data for our golf course? (New York)

A: The Northeast Regional Climate Center (NRCC) is an excellent source for obtaining historical and present weather data from regional weather stations located throughout the Northeast and Mid-Atlantic states.

Similar regional climate centers can be found for the Southeastern, South Central, Midwestern, High Plains, and Western states. The climate centers can also download weather information, including ET rates, if desired.

Visit the NRCC website at www.nrcc.cornell.edu/ or contact them at (607) 255-1751 to learn more about their services or the other Regional Climate Centers.

Q: Is there any difference between the various kinds of ice covers that occur on greens? I have heard that ice that is milky or white in color is less likely to cause winterkill than the hard clear or black ice that we frequently see. Is this true? (Pennsylvania)

A: Winterkill of turfgrass is a poorly understood concept, but more research is being done on this topic. Recent research at Penn State University suggests that while the ice cover may appear different, its permeability is the same. Thus, there is very little difference between white and black ice for turf suffocation potential. Duration of ice cover is more important in determining the potential impact on winterkill of turfgrass.