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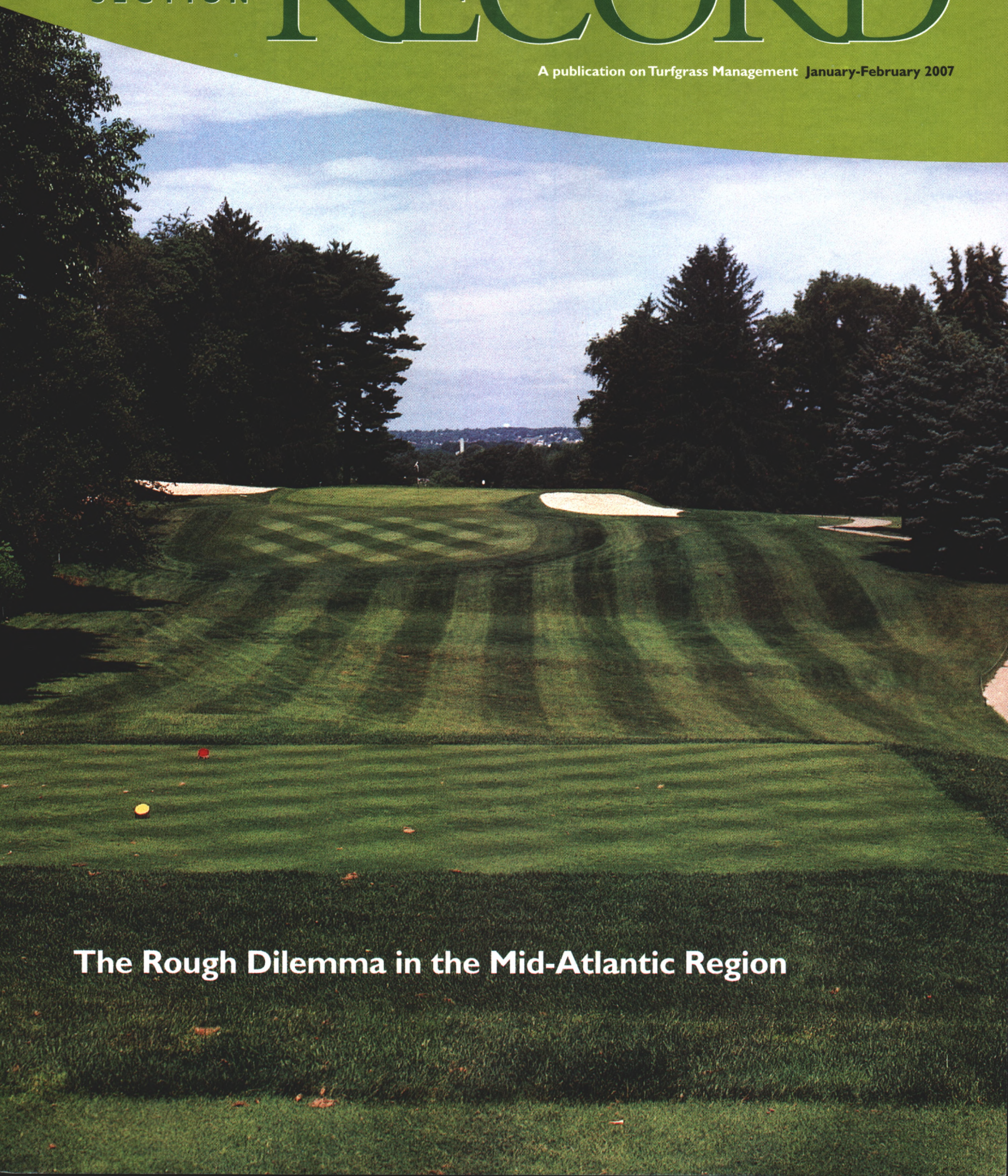

The Rough Dilemma in the Mid-Atlantic Region

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Cover Photo
Increasing expectations for turfgrass quality have now reached roughs, presenting a whole range of new challenges to golf course superintendents.

Where irrigation coverage is inadequate to maintain rough during periods of drought, labor-intensive, roller-base sprinklers must be used to prevent drought damage to the grass.

The Rough Dilemma in the Mid-Atlantic Region

Establishing uniform rough and maintaining it through summer heat provides significant challenges for golf course superintendents.

BY DARIN S. BEVARD

Golfer expectations for turfgrass quality have increased since the game's beginnings. Fast, smooth greens, tightly cropped and uniform fairways, and firm, consistent bunkers are expected on a daily basis. Recently, expectations for playing quality and appearance of rough have increased dramatically. These expectations exist in spite of stretched budgets, harsh summer weather, limitations of existing rough grasses, and hundreds of golf carts running through roughs on a weekly basis. Rough is expected to be uniform, dense and, for lack of a better term, pretty, regardless of the vast acreages that often are involved. The larger the area to be managed, the lower maintenance intensity will be. Mowers are used to produce stripes in the rough in a manner similar to fairways. Course officials seem to be especially critical of rough quality in the immediate green surrounds due to the delicate shots played from these areas.

New and renovated golf courses establish uniform rough grasses from seed and sod. This provides a great advantage in rough quality compared to older facilities that paid no more than passing attention to rough conditions until recently. Nonetheless, golfers at older facilities are demanding better rough conditions, and efforts to improve rough are increasing. Unfortunately, establishing better rough grasses into existing, mixed stands of turf has proven to be very difficult, and once rough is successfully established, a myriad of problems awaits the turfgrass manager.

Rough that is under stress can provide good playability and maintain a good appearance as long as cart traffic is regulated.

Obviously, if you have warm-season rough, bermudagrass and zoysiagrass are the logical choices. This article will focus on the challenge of establishing new grasses into existing rough and maintaining cool-season roughs in general in the Mid-Atlantic Region. Choosing the proper turfgrass species, establishing the grass, and maintaining turf quality throughout the growing season are critical to meeting golfer expectations.

BEFORE YOU GET STARTED

Irrigation coverage is an important requisite for successful rough renovation and management. Irrigation systems are now installed with sets of irrigation heads that specifically address the rough, separate from tees, fairways, and greens. Tees, fairways, and greens require less irrigation than rough over the course of the growing season. Roller-base sprinklers and hand watering must be used when older irrigation systems do not provide good coverage. These practices are labor intensive, but necessary. Roughs will decline during extended periods of dry weather if the irrigation system is not designed specifically for rough areas, or labor resources are not available for supplemental watering. Good irrigation coverage is especially critical during establishment to sustain newly emerged seedlings or new sod. Without good rough irrigation coverage, establishment of new seedlings will be difficult, and any progress that is made during the fall and spring can be lost during the summer months.

Initial capital to upgrade the irrigation system is expensive, but in the long term, this can be recovered through more efficient watering that requires less labor. If expectations are high for rough conditions, a proper irrigation program is crucial.

CHOOSING THE RIGHT GRASS

Choosing the right cool-season grass for rough in the Mid-Atlantic Region may be the biggest challenge of all, because there may not be a "right" grass. Generally, perennial ryegrass, Kentucky bluegrass, and tall fescue are used to establish primary rough. Each of these species comes with advantages and disadvantages in terms of establishment, appearance, and maintenance.

Perennial ryegrass is easily established. Seeds are large, and seedlings are aggressive. Rapid seed germination makes ryegrass more competitive with annual bluegrass (*Poa annua*) when seeded in late summer or early fall. Leaf texture is fine, and the grass has a dark green color and good wear tolerance. Perennial ryegrass is very tolerant of most herbicides needed to control weeds throughout the growing season. Perennial ryegrass sounds like the perfect rough grass until weaknesses are discussed.

The biggest weakness of perennial ryegrass is susceptibility to widespread turf loss due to disease. Gray leaf spot is particularly troubling. Control of gray leaf spot is expensive, and disease occurrence is difficult to predict. Perennial ryegrass varieties resistant to gray leaf spot are available and should be used. *Pythium* blight also can be devastating to perennial ryegrass, rapidly thinning the turfgrass stand in a single night. Cold tolerance is marginal.

Kentucky bluegrass is used widely for rough. Its color and texture make it a popular choice, and it performs well alone or in combination with other grasses such as tall fescue or perennial ryegrass. Rhizomes of Kentucky bluegrass increase sod strength and help it to heal from moderate damage without overseeding.

Weaknesses of Kentucky bluegrass include slow germination and weak seedlings. New seedings of Kentucky bluegrass are very successful, but establishing them in existing turf that contains annual bluegrass and other grasses is difficult. In the Mid-Atlantic Region, Kentucky bluegrass can be fickle when growth regulators are applied. Sensitivity to herbicides that are used to control other weeds, such as *Poa annua*, is also a concern. Summer patch incidence has increased on Kentucky bluegrass stands in recent years, and in some instances, this has occurred despite use of preventative fungicide programs.

Tall fescue use in rough has increased significantly in the last several years. Finer textured (turf-type) varieties have improved acceptance of tall fescue over its coarse-bladed predecessors. Tall fescue has good color and good traffic tolerance. It germinates quickly, but not as quickly as perennial ryegrass, and its texture is coarser than Kentucky bluegrass and perennial ryegrass. Tall fescue is susceptible to foliar diseases such as brown patch and pythium, but it is not impacted by gray leaf spot in the Mid-Atlantic Region. Soil-borne diseases such as summer patch are not a problem. While tall fescue is prone to some diseases, they are more easily identified and controlled than the diseases that affect perennial ryegrass and Kentucky bluegrass. Some tall fescue varieties are less susceptible to brown patch than others, and they should be used when they are available. Tall fescue is tolerant of most herbicides commonly used for weed control in rough.

Other turfgrasses used occasionally for rough include fine fescues, but their use is sporadic. The introduction of hybrid bluegrasses, created by a cross between Texas bluegrass and Kentucky bluegrass, have raised hopes for roughs, but use of these grasses is still too infrequent to establish a track record. Limited research that has been conducted suggests that hybrid bluegrasses may not perform any better than tall fescue in golf course rough. Ultimately, perennial ryegrass, Kentucky bluegrass, and turf type tall fescue are the primary options for cool-season rough in the Mid-Atlantic Region.

THE ANNUAL BLUEGRASS PROBLEM

Most golf courses have been in existence for many years. For many of those years, expectations for roughs were much lower than they are today. Maintenance was minimal, and the only irrigation they received was along the edges of the fairways. Rough on these older courses generally is composed of a variety of grasses that are not

Poor conditions in the collar to rough transition area can be particularly frustrating to golfers when they need to execute a delicate shot from this turf. When this transition is poor, a shot that misses the green by three or four yards receives a better lie than one that barely trickles off the collar. Sodding usually is the only way to fix this transition problem.

Hand mowing of green surrounds is becoming more commonplace. The opportunity for mechanical damage is greatly reduced on slopes when hand mowing is employed. The problem is that labor and financial resources need to be increased to perform hand mowing.

capable of meeting current expectations on a season-long basis.

Often a primary component of this mix is annual bluegrass. This grass has evolved to perennial forms on greens and even fairways, but the majority of annual bluegrass in the rough is the true annual biotype, which is considered a weed in many northern areas. Annual bluegrass in roughs generally germinates in the early fall, overwinters vegetatively, produces seed in mid-spring, and declines with the first summer heat. Look at it as winter crabgrass! Quality declines in the latter part of June and persists into late September and even October, at which time annual bluegrass readily reestablishes from seed to continue the cycle that leads to annual decline. The role of annual bluegrass in the rough dilemma cannot be overstated.

ESTABLISHMENT

The annual bluegrass problem significantly affects the establishment of desirable new grasses in existing rough. Generally, programs to increase desirable grasses in existing areas of annual bluegrass are performed in late summer or early fall. Rough aeration and interseeding with perennial ryegrass, Kentucky bluegrass, or tall fescue is performed at the very time annual bluegrass germination is most prolific. With the first September rains and cooler temperatures, annual bluegrass seems to jump out of the ground. This weedy grass is better equipped to compete in existing turf stands than the grasses we wish to establish. Intense competition from annual bluegrass both prevents establishment of newly seeded grasses and reduces their ability to spread.

Regardless of which turfgrass is being seeded into existing turf, seeding rates need to be two to three times greater than they would be for newly established areas. Aggressive core aeration and slit seeding can help increase the degree of establishment. Each grass has strengths and weaknesses for establishment. If annual bluegrass is a concern, herbicides for its control should be applied after new seedlings are well established, usually after November 1. Successful annual bluegrass control may require additional seeding in the spring to fill voids that are created.

Because of its slow establishment, Kentucky bluegrass is a poor option for interseeding. Residue from late spring or early summer applications of preemergent herbicides has greater impact on the small seeds of Kentucky bluegrass compared to larger seeds of perennial ryegrass and tall fescue, further complicating the matter. Kentucky bluegrass seedlings also are more sensitive to annual bluegrass herbicides, such as Prograss. Though many try, interseeding to establish Kentucky bluegrass in existing rough generally fails. If Kentucky bluegrass is going to be established from seed, existing turf should be sprayed out with a non-selective herbicide to eliminate the competition.

Tall fescue is better equipped to compete with annual bluegrass than Kentucky bluegrass, but it can still be difficult to establish if seeding is performed after Labor Day. Good establishment of tall fescue from seed in existing stands takes commitment and requires tolerance for poor spring playability for several years. Interseeding turf-type tall fescue can be successful, but it usually takes three to four years to establish a good (not great)

stand of this grass. A seeding rate of 10 lbs. per thousand square feet is recommended.

Of the three grasses profiled, perennial ryegrass establishes itself much better in mixed turf stands due to its fast germination and aggressive seedling vigor. Perennial ryegrass is very tolerant of Prograss applications, even early in its development, providing a good option for annual bluegrass control. In situations where resources are limited, perennial ryegrass produces good rough during the fall, spring, and early summer, compared to tall fescue and Kentucky bluegrass. Problems with perennial ryegrass generally start in mid-July, when summer stress is in full swing. *Pythium*, gray leaf spot, and dollar spot can quickly infect perennial ryegrass, causing a rapid decline in quality. In some years, this decline in quality is less severe than others. It all depends on the weather.

In summary, roughs can be improved through interseeding, but it takes a long-term commitment and a lot of seed. There must be an understanding that the roughs will be only as good as the weakest turfgrass that remains in the population.

In recent years, several golf courses have implemented programs of stripping existing sod from regularly in-play areas and resodding them to provide uniform stands. This practice has been especially common on green surrounds. Kentucky bluegrass and tall fescue have been used alone, but a combination of these two grasses with approximately 85% tall fescue and 15% Kentucky bluegrass has been the most common. Tall fescue alone and in combination with Kentucky bluegrass is performing very well throughout the growing season. The addition of Kentucky bluegrass to tall fescue provides the appearance of a finer-textured rough than turf-type tall fescue alone.

The initial expense of sodding is high, but the results are immediate and dramatic. A uniform, dense rough is provided and greatly improves playability and aesthetics. Sodding defines a distinct edge between rough and fine turf areas. If the expense of aerating and seeding of rough over several years is considered, and given the results provided, sodding becomes a more reasonable option. Remember, every green surround does not need to be sodded at one time. Results achieved from sodding a single green surround can be the impetus for implementing a long-term sodding program to improve other areas.

MAINTENANCE

Although grass species are important, maintenance programs are the biggest factor in overall rough quality. A uniform stand of the right grass is certainly a big help, but available resources to maintain any area of the golf course dramatically impact quality. The resources allocated for rough maintenance usually are the biggest factor in rough quality. Expenditures affect seeding rates and determine whether large areas can be sodded to provide immediate improvement. Irrigation coverage, the use of fungicides to prevent turf loss, and options for herbicide applications to prevent long-term weed encroachment are related to available resources.

With cooler temperatures and moist conditions, annual bluegrass germinates rapidly and fills in voids where existing annual bluegrass died during the summer. The same areas generally will fail during the following summer if corrective measures are not taken.

Basic weed and insect control programs are necessary to maintain good rough. This is not optional. Preemergent herbicides are available to control crabgrass and goosegrass, and post-emergent products can be used for weed escapes. A wide range of herbicides are available to control clover, sedges, and broadleaf weeds. Regular programs that include broadcast and spot spray applications help keep weeds out of rough. The extent of the treatments generally is determined by available resources.

Long residual insecticides have simplified control of white grubs, which are the primary insect problem of roughs in the Mid-Atlantic Region. Late June or early July applications can provide season-long control. Without insecticide applications, damage from white grubs, as well as from the animals that use them as a food source, should be expected.

The biggest addition to rough programs in recent years is the use of fungicides. Expectations are driving this trend for better or worse. In many cases, golf course superintendents are expanding fungicide treatments into roughs without an increase in budget. The result is less intense maintenance for other areas of the golf course in favor of fungicide applications in roughs. However, one or two properly timed fungicide applications during the summer months can dramatically limit rough decline if annual bluegrass is not a significant component of the turf population.

Disease susceptibility is one factor that makes turf-type tall fescue attractive for roughs. The primary pathogen — brown patch — can easily be diagnosed and treated. Summer patch in Kentucky bluegrass requires multiple preventative treatments, and these treatments are not always successful. Gray leaf spot can seriously thin stands of perennial ryegrass before one even realizes the disease is present.

Good fertility programs are needed to maintain thick, healthy rough. Adequate nitrogen fertility in roughs usually leads to golfer complaints during the spring and early summer because of the difficulty of the rough, requiring a delicate balancing act to satisfy both the golfers and the grass. If adequate fertility is not provided, the appearance and quality of the grass will suffer.

Highly trafficked areas require special maintenance attention. Good traffic regulation can spread wear to limit concentrated traffic damage, but areas that receive concentrated golf cart traffic or walk-on/walk-off areas need higher rates of nitrogen to maintain expected conditions. More aggressive aeration is also needed to combat compaction in highly trafficked rough areas.

One final trend that has emerged is the hand-mowing of roughs around green surrounds. The goal is to limit mechanical damage that occurs from riding mowers being used under moist conditions. The mechanical stress damage from hand mowers is far less than that of riding machines, especially on sloped areas. Obviously, many courses do not have the resources to hand-mow greens, much less hand-mow green surrounds.

CONCLUSION

Many different factors affect rough quality. In the Mid-Atlantic Region, disease pressure during the summer months can produce a rapid decline in rough quality. This is especially true if annual bluegrass is a primary component. Perennial ryegrass, Kentucky bluegrass, and turf-type tall fescue all have strengths and limitations. Tall fescue is holding up best to environmental stress in the Mid-Atlantic Region where reasonable irrigation coverage is present. At this point in time, it seems to be the best option for roughs, and tall fescue should be included as part of rough turfgrass populations. Regardless of the grass established in rough, at some point there is a good chance it will be the wrong choice.

The bottom line is that, as expectations rise for roughs, more inputs must be earmarked for rough maintenance. This includes capital to establish better grasses and more money in operating budgets to implement more intense rough maintenance programs. Unfortunately, many golf courses do not have the financial resources or the grasses in place to keep up with this trend. Nevertheless, expectations continue to grow. Establishing rough that meets these new expectations requires commitment to the programs and funding of resources that are needed to implement them. There are no shortcuts in this process, and there is no perfect cool-season grass for roughs. The expectations for roughs beg the question of whether limited resources should be used to maintain uniform conditions in a turfgrass area that is supposed to impose a penalty for errant shots. This is the basis of the rough dilemma.

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Summer patch can cause severe thinning in stands of Kentucky bluegrass, even when fungicides are applied. In this photo, the tall fescue in the center of some of the patches is not affected.

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Research *You Can Use*

Protecting Water Quality On and Off the Golf Course

Design features for filtering fertilizer nutrients.

BY ERIC MILTNER

In recent years, issues such as storm water retention, wetland preservation and mitigation, and preservation of wildlife habitat on golf courses have received increasing attention throughout the design, permitting, construction, and management processes. This is in addition to the now ever-present scrutiny on maintaining water quality. In the Pacific Northwest, sand topdressing and/or building courses with extensive sand caps is becoming the norm. This is done primarily to allow play to continue during the mild, wet winters. The sandy soil profile provides for rapid infiltration of rainfall. This reduces the potential for surface runoff, provides a large volume of temporary water storage in the pore spaces of the soil (storm water retention), and improves stability for both golfers and maintenance equipment. However, the sandy soil also creates an environment of potentially increased mobility of fertilizer nutrients used on the golf course. Measures to mitigate this potential mobility are critical and can be accomplished through design and construction or management practices, or both.

Wet cells that seasonally hold water are one way of potentially reducing fertilizer from leaving the property.

This article describes research conducted at Trophy Lake Golf and Casting Club on Washington State's Key Peninsula. A natural 18-acre lake surrounded by wetlands is the central drainage basin for 15 of the golf course's 18 holes. The entire course was constructed with a 6- to 10-inch-deep sand cap to allow for rapid infiltration and storm water storage, preventing large influxes into the lake during storm events. Such influxes can disrupt wildlife habitat in the lake and in the stream that exits the lake. In addition to the sand cap, bioswales (mounded berms), wet cells (low-lying areas that seasonally hold water), constructed wetlands, and tall grass buffers were included at edges of fairways and in roughs. These features were designed to intercept runoff water and shallow subsurface flow, allowing for filtering of nutrients through the actions of plants, soil, and microorganisms.

Six sites throughout the course were selected for monitoring the effectiveness of these design and construction techniques. These areas had obvious flow gradients created by surface contours and directed water across slopes and into and through the filtering features previously mentioned. The monitoring sites can be thought of as mini-watersheds. Instruments that enabled collection of soil solution were installed upslope, within, and down-slope from bioswales, wet cells, and constructed wetlands. (Soil solution is the water within the soil profile, including any dissolved solutes that might be present.) The samplers were located at the interface of the sand cap and the less-permeable subsoil below. Soil solution moving through the profile collects in the sand, above the less-permeable subsoil, allowing for its extraction.

Thirty-six samplers were initially installed, and 15 more were added in critical areas as the study progressed. Samples were collected periodically and analyzed for nitrate-nitrogen and ortho-

phosphate (soluble phosphorus), two potentially important pollutants of surface and ground water. Nitrogen (N) and phosphorus (P) were both regularly applied to golf courses as components of the overall maintenance program.

On 15 dates between May 2002 and June 2004, 396 individual samples were collected from either the soil solution samplers or from free (standing) water present in the wet cells, wetlands, and lakes. Most of these samples (329, or 83%) contained less than 1 part per million (ppm) nitrate-N. In 86 (22%) of these samples, nitrate-N was non-detectable (less than 0.01 ppm).

Fourteen of the soil solution samples (3.5%) had nitrate-N levels above the EPA drinking water threshold of 10 ppm. Some of the soil solution samples collected from down-slope areas where water accumulates had relatively high nitrate-N concentrations (3 to 60 ppm) on selected dates. Typical locations were bioswales and unmowed tall grass buffers located between fairways and constructed wetlands. Following these findings, additional samplers were installed at a depth of 2 feet into the subsoil at these locations. Subsequent sample collection did not show high nitrate-N concentrations in these deeper samplers, indicating no appreciable downward movement of nitrate-N. In addition, nitrate-N concentrations were always lower in locations further down-slope from these near-surface accumulations (within wetlands or in soil on banks of the lake). The highest concentration of nitrate-N found in the surface water of wetlands or lakes was 1.4 ppm (only 2 samples were above 0.25 ppm, and these were both in constructed wetlands).

In addition to nitrogen, 342 of the samples were analyzed for orthophosphate (there was not sufficient volume in some of the samples to analyze for both). Eight-one percent (278 samples) were below the surface water quality threshold of 0.05 ppm (a concentration often cited as one above which algal blooms may occur). Orthophosphate was not detected (less than 0.01 ppm) in 101 (30%) of the samples.

The results of this study indicate that even in fertilized fairways, soil solution concentrations of N and P were usually below recognized water quality thresholds. Grasses are extremely efficient in scavenging nutrients from the soil due to their dense, fibrous root systems. As soil solution moved down-slope through the monitored areas, concentrations remained low. In the few cases where nutrient concentrations increased in buffers and wet cells, there was no evidence that these higher concentration waters continued to move down-slope or percolated deeper into the soil profile. This indicates that as the soil solution moved through these areas, where the rate of flow was lower due to gentler slopes, nutrients were likely filtered from the water through uptake by plants or soil microorganisms or immobilization by other soil processes. Nutrient concentrations in the native wetland and lake were not impacted by golf course maintenance practices.

When the potential movement of water and dissolved nutrients from the golf course to surrounding areas is a concern, grass buffers, bioswales, wet cells, and constructed wetlands can be useful tools in maintaining water quality. Increasing the residence time of the soil solution on the golf course is critical and can allow the grass root system, as well as other soil organisms, to effectively filter nutrients from the water before it leaves the golf course site.

Streams and water features require very careful applications to the surrounding areas. Buffer strips help minimize nutrient and chemical introductions to the water.

The author would like to thank Ryan Vohs, golf course superintendent at Trophy Lake, and the entire maintenance crew for their assistance and cooperation. This research was funded by the Northwest Turfgrass Association and the USGA.

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Infection, Disease, and Symptoms

The perils of turfgrass disease identification and management.

BY STEVEN J. KAMMERER

Turfgrass pathology and disease management can be a real challenge! The causal agents of diseases can be very small, their life cycle very short or very long, and the expression of visible symptoms deceptive. When symptoms are apparent, disease may be the result, not the cause. Turfgrass diseases can be caused by a number of microorganisms, including viruses, bacteria, fungi, and nematodes. The majority of turfgrass diseases are caused by fungi. To our benefit, the majority of fungi are either beneficial or else incapable of causing disease.

Turfgrass diseases are either foliar or soil-borne. Foliar diseases are easier to identify, as the turf foliage is easily recognized as being spotted or blighted. Sometimes, fungal structures also can be seen with the naked eye or with a 10× hand lens. I prefer using an 8 × 30 monocular 25/45× macroscope (R.F Inter-Science Co., N.Y.), which is portable and very easy to operate. It is amazing what you can see and the money it can save you when scouting your greens for potential problems. When fungal spores and mycelium are seen, it is important to discern whether the fungal growth is on living turf tissue (green to slightly chlorotic leaves), versus fungal growth on the lower leaves that are the first to senesce. The presence of fungal growth on living turfgrass tissue is an early indicator of possible problems. Most fungal structures are either small or transient, so they might not be as apparent as, say, an army worm or a clump of crabgrass. The best time to look at above-ground, suspect diseased areas is early in the morning when dew is present. As the free moisture evaporates, fungal mycelia are less visible.

Cottony *Pythium* mycelium can often be seen in the early morning hours before the turf is mowed.

Professional diagnosticians will first spend some time in properly preparing the sample. All thatch, litter, soil, and dead tissue must be removed. The remaining turfgrass tissue is then cleaned and surface sterilized to exclude saprophytic fungi that often come in after the pathogen. Spores are like the fingerprint of a fungus, as they are usually very unique. With a microscope, a diagnostician looks for spores, utilizing a disease key to identify a specific fungus. Definitive diagnosis utilizing spores is dependent on finding the spores inside the living tissues of the turfgrass plant.

Foliar diseases such as dollar spot, when identified early, are easier to cure with fungicides, since the root system and crown (meristematic region) are usually still functioning to outgrow the disease symptoms. Soil-borne diseases are much more difficult to identify, since the causal agent may or may not be present when the turfgrass roots are dug up. It is difficult to separate the true causal agent, the pathogen, from all of the other soil microorganisms.

When diagnosing a questionable area of turfgrass, we may see mycelium and spores and conclude, "Aha, disease!" This decision may be premature. Most fungi are not capable of causing disease, and many are saprophytic, meaning they feed on dead organic matter and are non-pathogenic.

When turfgrass dies or is dying, many saprophytic fungi often come in to take advantage of this easily available food source. At the stage that the sample is taken, the pathogen may be absent or in an inactive state but overwhelmed by saprophytic fungi.

Most turfgrass diseases start with spores, which are the reproductive seeds of the fungus, and are usually the start and the end of the disease cycle. Not all turfgrass pathogens produce spores,

Some so-called diseases are non-pathogenic and occur as a result of aggressive cultural practices and/or harsh weather conditions.

however. Disease begins with germination of the fungal spore or reactivation of dormant mycelium (connective body/tissue of fungi). This germination or reactivation usually occurs at specific temperatures and moisture/humidity durations. Germination of oospores of *Pythium aphanidermatum* (*Pythium* blight) and movement of the resulting zoospores (motile spores) is triggered by natural exudates from plant roots coupled with very wet conditions. Infection occurs when the fungal germ tube (similar to a root) contacts susceptible turfgrass tissue and penetrates that tissue. Fungal pathogens can be aggressive and especially adept at getting past the turf's natural defenses. Both fungi and nematodes are unique in that they can directly penetrate living, healthy leaves, crown, and roots.

Following penetration of the living turfgrass tissue, the pathogen breaks down the turfgrass tissue with enzymes and begins to feed. While feeding, the fungus grows and begins to reproduce by producing spores. The infected tissue then begins to die and exhibits symptoms. This is one of the perils of a curative disease management program: By the time symptoms first become apparent, reproduction already may have occurred.

While there can be many life cycles a year (epidemics) of *Pythium* blight, dollar spot, and brown patch, *Gaeumannomyces graminis* strains (bermudagrass decline and take-all patch) and the fungus that causes spring dead spot (*Ophiosphaerella* spp.) are very slow growing and have one life cycle a year. For this reason, it is much more difficult to accurately identify the slower-growing fungi as a disease, because by the time the symptoms are apparent, the fungus is most likely in a dormant or inactive state. If the tissue is dead or dying, the sample will be contaminated with fungal and bacterial saprophytes. Some of the more predominant fungal saprophytes are *Curvularia*, *Rhizopus*, *Leptosphaerulina*, *Penicillium*, and others.

Spraying fungicides to knock out these fungi may delay the senescence or ultimate death of the turfgrass tissue, but the conditions that the turfgrass is growing under must be rectified for the turfgrass to fully recover. This is analogous to a cattle rancher who has wolves killing cows every day, and instead of fortifying his fences or defenses to exclude the wolves, the rancher focuses his efforts on shooting the saprophytes coming in to feed on the dead/dying cows.

After disease symptoms appear, if the turfgrass area is sprayed once, twice, or three times with various fungicides, the pathogen is almost certainly gone or in a very weakened state. Spraying a fungicide after spores develop can help in the prevention of additional infection, but it won't always result in recovery of the infected tissue. If the turfgrass plant is infected and dying, it will be more difficult to get systemic fungicides into the plant when the roots and leaves are not functioning normally. For this reason, it is much more difficult to cure existing infections or disease by a curative chemical approach alone. This is also why most fungicides are recommended and more efficacious when applied preventively. Modification of the environment and utilization of cultural practices to alleviate stresses is as important, if not more, than the spraying of fungicides.

When considering all costs, prevention is usually cheaper. Consider a scenario where some unknown disease causes 30-40% turfgrass loss on your greens. What is the cost of all the panic spraying of fungicides after the turfgrass began to die? Was it a disease or was it a cultural problem that set off a general turfgrass decline? What is the cost of the loss of rounds and revenue, the cost of additional labor spent addressing the problem, and, worst case scenario, what is the cost of re-sodding the damaged areas?

There are also fungi that will feed on other fungi. Some of the pathogenic fungi, such as *Rhizoctonia* spp., are more adept at existing saprophytically. Usually these fungi are the ones that only cause disease when the turfgrass is very stressed, but they are always present in the thatch or soil. Turfgrass stresses are many and well documented. The best advice for disease management is to prevent turfgrass stress first.

There are tremendous information resources and guidance available from universities, the USGA, and manufacturers in the turfgrass market. Historical disease data are available from the stand-

point of internet Web sites that give forewarning of when your turfgrass is most susceptible to infection. The USGA, various other associations, universities, and companies have articles and data indicating proper cultural practices for the various turfgrass species and when these practices should be performed. This is all part of a comprehensive preventive approach to disease control. Disease control is disease prevention. Damage control follows after disease occurs.

Some things to consider when addressing turfgrass problems that are suspected to be caused by disease:

- Identify symptoms early, and send samples to diagnostic labs *before* spraying with a fungicide.
- Send turfgrass samples to your local university or to a diagnostician familiar with your area who knows the environment, knows turfgrasses, and is experienced with the local geography. This takes advantage of experience. Local diagnosticians are usually networked with other experts in the area who can visit your course and look at the problem. As an example, if the green is low, surrounded by trees, and has poor air movement, this cultural problem may never be known by the diagnostician without visiting the site.

Speed does not guarantee accuracy. Diseases such as bermudagrass decline and take-all patch can take months to occur; it is not realistic to expect an accurate diagnosis in less than 24 hours. However, fungi in this same genera are commonly found in soils but aren't necessarily pathogenic. These diseases may necessitate growing the fungus out in petrie dishes from the infected, not the dead, turfgrass tissue.

- Analyze your records — what happened prior to the onset of symptoms? Provide this information along with spray records and photographs when sending a sample out for diagnosis.
- Assess your environment. What turfgrass varieties are you maintaining? Under what conditions are you maintaining those varieties? Is the turfgrass more likely suffering from adverse cultural and environmental conditions?

Sometimes, when the problem is concluded not to be a weed or insect, then disease is the conclusion. Disease is often an indicator of cultural problems. It is easier to address something before you get to the endpoint, whether that endpoint is caused by a disease or a culmination of a lot of other adverse factors.

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Plant-parasitic nematodes can severely injure turfgrass roots and cause above-ground turf quality problems. The injured roots also can be colonized by secondary pathogens.

Snow Way

BY MATT NELSON

Late winter or early spring snow removal from putting greens is a common practice in the Rocky Mountains of the U.S.

Winter injury to putting greens can affect playing conditions at high elevation or northern golf courses for an entire season. Experienced golf course superintendents and course officials usually will try to implement every reasonable precaution possible to limit the potential for winter damage, but specific weather conditions may, and often do, thwart the best preventative programming. While there are no guaranteed methods to prevent winterkill on golf course turf, late winter/early spring snow removal has become widely practiced at moutainous and northern golf courses to help prevent damage associated with snow and ice cover. Sans the slide guitar of Joe Walsh, this article will address snow removal practices the *Rocky Mountain Way.*

Winterkill of putting green turfgrass usually occurs as a result of desiccation, disease, or freeze injury. Of these, freeze injury is typically the most difficult to prevent. Freeze injury may occur from exposure to lethal temperatures without snow cover or other insulation when ice crystals form within and around cells of meristematic tissue. During freeze/thaw events, water may be drawn out of plant cells as ice crystals form around them, causing dehydration and membrane collapse. Mitigating damage from the latter form of freeze injury usually is accomplished by limiting surface moisture in late winter or early spring by removing snow and ice.

DON'T REMAIN IN THE DARK!

There are three factors commonly associated with freeze injury: shade, poor surface drainage, and significant populations of *Poa annua* (annual bluegrass). Removing trees, adjusting grade or design, and establishing creeping bentgrass are successful methods of reducing the potential for winter injury associated with freeze/thaw events. ***Never*** plant spruce or other evergreen trees within 125 feet to the southeast, south, or southwest of greens. This is a recipe for eventual disaster at northern locations where extensive shade will be cast when the sun angle is low during winter months. If evergreen conifers already exist in the aforementioned proximity of putting greens, cut them down.

Shade in the late summer and fall limit a turfgrass plant's ability to achieve maximum winter hardiness by compromising photosynthesis necessary for energy fixation and carbohydrate storage. Stored energy enables a plant to tolerate cold temperature exposure and maintain hardiness for a longer period of time, which is critical to survival during freeze/thaw events of late winter or early spring. Shade during the winter prolongs snow and ice cover and may cause more freezing events. Shade during spring delays soil warming necessary for growth and recovery. Shade will exacerbate winterkill problems on greens with a northerly slope aspect. Snow removal alone will not consistently prevent winter injury to shade-affected greens; thus, allowing for sunlight penetration is an important component of winter turf survival.

PULLING THE TRIGGER

Removing snow and ice from putting surfaces involves experience with the site and local climate conditions, judgment, and some confidence in the weather forecast. At most sites across the Rocky Mountain region of the U.S. (and high-elevation sites in the Sierra and Cascade mountains), this will occur in early to mid/late March. Snow provides insulation that buffers turf from temperature extremes; thus, removal too early may expose the turf to lethal cold temperatures or unseasonably warm temperatures that cause a rapid loss of winter hardiness and potential damage if temperatures drop again significantly. Ice layers that form early in the winter pose a unique challenge, since relatively little is known about the factors contributing to turf failure under ice, including the condition of the turf when ice formed, ice composition, and how long

Shovels may be necessary to get the final few inches of snow off of a green.

the turf can safely tolerate ice cover. Creeping bentgrass will tolerate ice much better than annual bluegrass. Some superintendents have removed an ice layer in midwinter and blown snow back onto the greens to provide insulation.

On the other hand, waiting too long to remove snow can result in increased disease activity and expose turf that has already broken dormancy. Regular monitoring of turf through the winter is a good idea as a method to gauge its condition and also help determine when to remove snow. Dormant turf will be more tolerant of cold night temperatures once snow is removed.

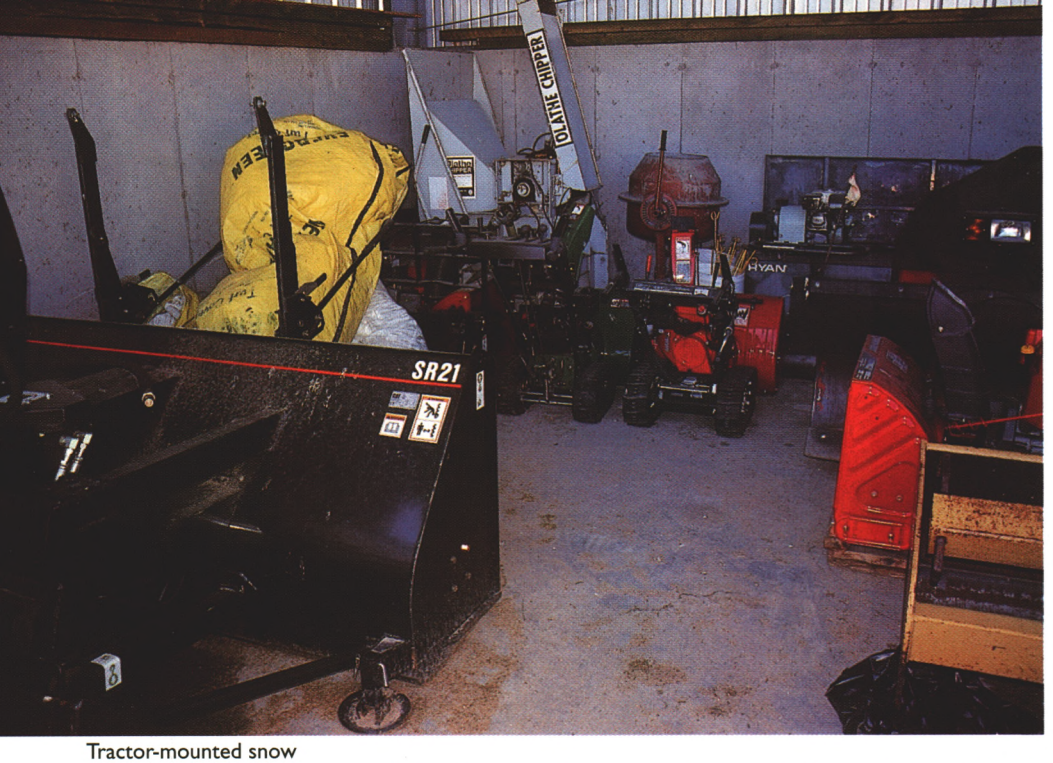
Most turf managers implement late winter snow removal when the weather forecast calls for melting temperatures and sun. Although severe weather may still occur, the likelihood of extreme cold is at least lower as spring begins. Favorable weather allows turf to gradually break dormancy as the days begin to warm. The benefits of removing snow from putting green turf include the following:

- Reduced turf exposure to melting snow and ice and less chance of freeze injury.
- Enhanced disease control at sites with extended snow cover. Disease prevention products may begin to lose efficacy after many months, and additional applications are usually made following snow removal.
- The turf can begin growth and/or recovery if favorable weather conditions occur. This can be valuable if winter injury exists, often a result of rapid and/or severe freezing in fall without ample hardening time.
- Some golf course superintendents will conduct core cultivation at this time of year to minimize disruption to golfers. This typically requires plenty of available labor, a means to transport cultivation equipment to greens, permeable covers to accelerate warming and recovery, and decent weather.

TECHNIQUES

A myriad of snow removal tools and practices can get the job done effectively. At most mountain golf courses, large, tractor-mounted snow blowers are used to clear deep snow packs to within a foot or less of the putting surface. These same machines also are used during the winter to clear paths to the greens for monitoring and access when snow removal is initiated. Smaller, walk-behind snow blowers can then be used to more safely remove snow closer to the turf. Shovels will take care of the rest if rapid melting is not likely. Keep these tips in mind for optimal results:

- Set poles or other marking devices in the fall to delineate putting green perimeters and abrupt contours, bunkers, streams, etc. Marking will help avoid mechanical injury when blowing or plowing snow, and it will indicate that removed snow is far enough from the green to not obstruct



Tractor-mounted snow blowers, walk-behind snow blowers, and green covers are tools commonly used to remove snow from greens and safeguard turf health in the Rocky Mountains.

surface drainage. Clear snow far enough from the greens to prevent snow on banks from melting back onto the greens or cause a shade problem if the banks are high enough. Avoid burying sprinkler heads or quick-couple valves.

- Have at least one person probe the snow pack out in front of the blower or plow to help the equipment operator gauge depth settings.
- Start snow removal early in the morning or on cloudy days when the snow is cold and firm. The snow will be lighter and can be blown away more easily from the green. Working while the turf is frozen also will reduce the potential for mechanical injury. Use warm afternoons to remove snow from tees and cart paths.
- Finish removing as much snow as possible from one green before going on to the next. Use small, walk-behind snow blowers after using larger equipment. Use shovels to remove remaining snow to the extent possible. Snow that is not removed will set up and become very firm and more difficult to remove than with the first attempt. At the least, cut paths for surface drainage off of the green.
- Darkening agents, including colored sand, compost, humates, or fertilizers, can expedite melting of the final inches of snow and ice. The more inert the product, the better.
- Realize that snow may need to be removed several times in the spring.
- Monitor the greens closely after they are cleared. Any standing water on the greens in the afternoon may freeze and could damage the turf. Use shovels or roller squeegees to eliminate puddles.
- Keep an eye on soil moisture between snow removal and activation of the irrigation system. Covering may be helpful, and snow can be added to high spots or crowns to prevent desiccation. Charge the irrigation system as early as possible and hand water if necessary.
- Sleds may be useful to haul mowers, spreaders, aerators, etc. out to greens cleared of snow while a significant snow pack remains across the rest of the course.
- Don't be afraid to damage the turf. A few nicks and dings will be easier to repair than widespread turf loss from disease or freeze injury.

NO GUARANTEES!

Although snow removal from putting greens is a common practice at golf courses throughout the Rocky Mountains with significant snow pack, clearing the greens does not guarantee that winter injury has not or will not happen. This program, however, does appear to increase the chances of turf survival and accelerate growth and recovery in most years. Improved winter management techniques, including snow removal, covering, disease control, winter watering, sunlight assessment, turfgrass renovation, and drainage, have helped reduce springtime crying that the greens are bad, and modern winter management in the Rocky Mountains is better than it used to be.

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Research *You Can Use*

Development of Creeping Bentgrass with Multiple Pest Resistance

University scientists adopt a team approach to improve this important turfgrass species.

BY MICHAEL CASLER, G. JUNG, S. BUGHRARA, A. HAMBLIN, C. WILLIAMSON, AND T. VOIGT

Creeping bentgrass (*Agrostis stolonifera*) is the premier grass for golf course putting greens and is one of the most desirable grasses for fairways and tees for much of the USA. Recent breeding advances demonstrate that genetic variation exists within creeping bentgrass for a range of pest resistances and stress tolerances. Many of these traits allow bentgrass to be grown in environments and under conditions that were impossible just a few years ago.

For many golf courses, maintenance of a high-quality turf requires frequent, varied, and intensive pesticide applications. Pesticide costs can consume up to 10% or more of the total budget for a highly managed golf course. Intensive management, including frequent and low mowing, irrigation, and heavy play, serves to enhance and/or spread the development of pest problems, particularly fungal diseases. In addition to their expense, pesticides represent a potential health and environmental hazard, both to golfers and to the surrounding environment, and they have limited efficacy[3,8] and lead to fungal resistance.[2,7]

Genetic resistance to disease pests is a widespread phenomenon in agricultural and horticultural plants. Disease resistance has been used to protect economically important plants for more than 90 years. There are many examples of genetic resistance that has been durable for more than 30 years without any need for fungicidal protection or increase in disease incidence.

While there has been much research on genetics and breeding of creeping bentgrass for individual pest resistances, there has not been a concerted effort to develop multiple-pest-resistant germplasm. Plants with multiple pest resistance will be required to have a significant impact on pesticide use. There is strong evidence for genetic resistance to snow mold and dollar spot in some clones of creeping bentgrass.[1,9,10]

There are currently several bentgrass breeding programs scattered around the USA, including programs in New Jersey, Pennsylvania, Texas, Rhode Island, Michigan, Illinois, Wisconsin, and Oregon. Many of these programs operate somewhat independently of each other. While there is some collaboration among public and private programs, particularly in the seed production and commercialization of publicly developed cultivars, both public and private programs compete in the development of cultivars to support the industry. As such, individual programs have difficulty in identifying and developing germplasm with multiple pest resistances. Each program has expertise, local knowledge, and environmental conditions to support identification of resistances/tolerances to a small number of pest problems. Only with collaboration among several diverse locations/programs can we hope to identify germplasm with the multiple pest/stress resistances that will be necessary to meet the challenges limiting adaptation of creeping bentgrass.

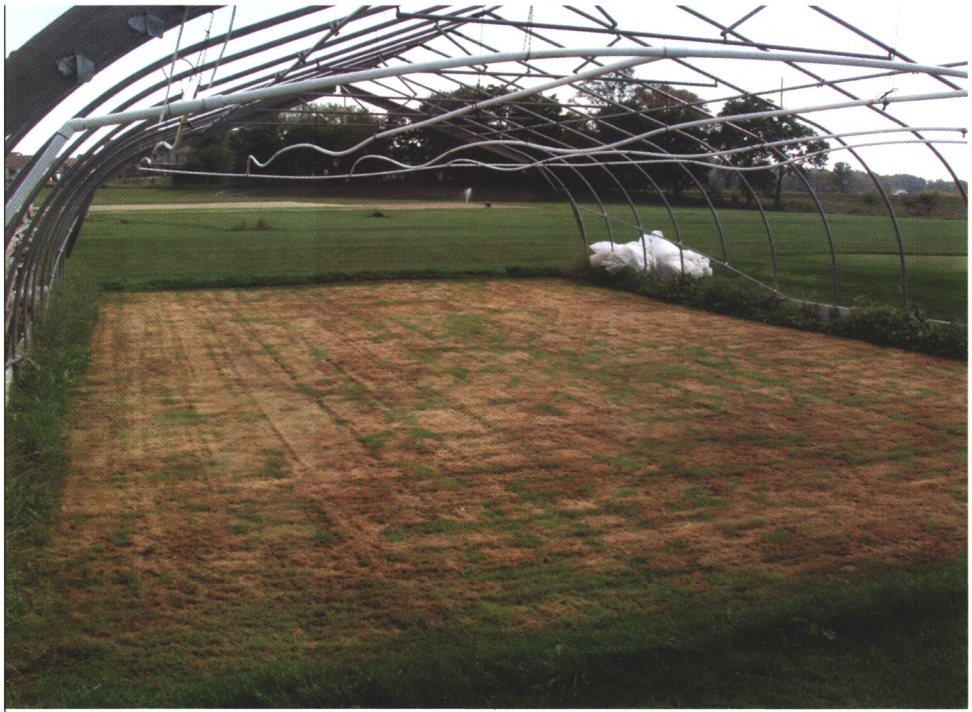
PROJECT DESIGN

The objective of this project was to develop elite clones of creeping bentgrass with multiple pest resistances and stress tolerances that can be delivered to the seed industry for use in synthesizing new creeping bentgrass varieties that are broadly adapted to a range of ecological and environmental conditions, including reduced pesticide application. The findings reported here are the result of the first three years of the Bentgrass Breeding Consortium between the USDA-ARS, the University of Wisconsin, the University of Illinois, and Michigan State University, supported in part by the USGA.

Three populations of creeping bentgrass clones were developed for this study. The Wisconsin population consists of a cross between two clones that differed in resistance to speckled and gray snow mold pathogens. This cross, consisting of 200 clones, also is being utilized in genetic linkage mapping[4] and disease-resistance mapping.[6] The

Michigan population consists of 200 clones collected from old golf courses in Michigan, largely for high turf quality and large patch size. The Illinois population consists of 200 clones that represent two generations of random mating of a population of clones collected from old golf courses in Illinois.

Each plant was vegetatively propagated in the greenhouse, and clonal material was exchanged among the three locations in February 2003. Clones were evaluated for disease and insect reactions as described below. Unless described otherwise, all ratings were made on a scale of 0 to 9, where 0 = plant completely brown from disease and 9 = no symptoms (plants with high values were most resistant and desirable). The rating scales were approximately linear with respect to the percentage of diseased tissue, so that a mean rating of 4.5 would represent approximately 50% diseased leaf tissue.



The so-called "chamber of death" resulted in damage to creeping bentgrass clones after inoculation with *Pythium* disease in August 2005.

UNIVERSITY OF WISCONSIN AND USDA-ARS

Speckled Snow Mold (*Typhula ishikariensis*)

The 600 clones were transplanted to the practice fairway at Gateway Golf Course, Land O' Lakes, Wis., in July 2003. Natural infection by *T. ishikariensis* was sufficiently severe and uniform to allow ratings to be made in spring 2004. Ratings were made in mid-April immediately after snow melt and again in early May, following recovery. In October 2004, plots were inoculated with a mixture of isolates representing all three biological varieties of this fungus — all known to be particularly virulent on creeping bentgrass. Plots were rated again in early spring 2005, shortly after snow melt.

Pythium Blight (*Pythium spp.*)

The 600 clones were transplanted into a perennial ryegrass fairway at the O. J. Noer Turfgrass Research and Education Facility new Verona, Wis., in June 2003. The fairway was covered with a metal-framed hoop house with the plastic covering normally removed. Plots were inoculated with a mixture of isolates of *Pythium spp.* in early August 2004, and they were covered with plastic to increase the temperature and humidity of the local environment. Plants were rated following two weeks of exposure to the pathogen under these conditions.

Pink Snow Mold (*Microdochium nivale*)

The 600 clones were transplanted into another perennial ryegrass fairway at O. J. Noer in August 2003. In October 2004, plots were inoculated with an isolate of this fungus that had previously shown virulence against creeping bentgrass. Due to lack of snow cover and mild winter conditions, there were no pink snow mold symptoms in spring 2005 and 2006.

Dollar Spot (*Sclerotinia homoeocarpa*)

In August 2004, the speckled snow mold experiment at Land O' Lakes, Wis., was inoculated with an isolate of the dollar spot pathogen that has been shown to be highly virulent against creeping bentgrass.[5] Ratings were made approximately four weeks after inoculation.

Black Cutworm (*Agrostis ipsilon*)

Two replicates of the pink snow mold experiment were inoculated with second-instar black cutworm larvae. In the middle of each bentgrass plant, a PVC pipe, 10 cm in diameter and 10 cm long, was driven approximately 1 cm into the ground. Five larvae were placed in the pipe, and the pipe was covered with nylon mesh to prevent birds from eating the larvae. After 10 days, pipes were removed and the number of surviving larvae was counted. The plots were mowed and two days later damage was scored on a 0 to 9 scale, where 0 = no feeding damage and 9 = plant completely brown (no regrowth). One replicate was inoculated and scored in mid-August and one replicate was inoculated and scored in mid-September.

UNIVERSITY OF ILLINOIS

Dollar Spot (*Sclerotinia homoeocarpa*)

The 600 clones were transplanted into a perennial ryegrass fairway at Champaign, Ill., in June 2003. The

experimental design and planting arrangement were as described above for each of the University of Wisconsin field trials. Plots were mowed at ½ inch, allowing the clones to grow laterally for the 2004 growing season. Plots were inoculated with the dollar spot pathogen in early June, and ratings were made in late June and mid-July.

MICHIGAN STATE UNIVERSITY

Gray Snow Mold (*Typhula incarnata*)
The 600 clones were transplanted into a perennial ryegrass fairway at East Lansing, Mich., in June 2003. Each plant was rated for reaction to gray snow mold in April 2004 and 2005, based on infections from natural inoculum.

Dollar Spot (*Sclerotinia homoeocarpa*)
Three isolates of the dollar spot pathogen were mixed and used to inoculate the entire trial at East Lansing in early July 2004. Plots were rated for dollar spot reaction two weeks later using the same rating scale as for snow mold. Recovery from dollar spot infection was rated five weeks after inoculation. This disease was rated again in 2005.

RESULTS

Pink Snow Mold, *Pythium* Blight, and Black Cutworm
Inoculations with pink snow mold, *Pythium* blight, and black cutworm failed to provide meaningful differences among the creeping bentgrass clones. In the case of *Pythium* blight, the disease pressure was so severe and uniform that all plants were heavily or completely damaged. All creeping bentgrass clones in the study were highly susceptible under the extreme conditions of this inoculation. For pink snow mold, the relatively few minor symptoms were due to mild winters with little significant snow cover. For black cutworm, the lack of variation among creeping bentgrass clones could only be attributed to extreme variation in the inoculation technique and/or the measurement of symptoms. Apparent differences among clones were not repeatable, indicating that there are environmental and/or cultural factors that obscure genetic differences among clones.

Variation among clones within populations was significant for all measures of snow molds and dollar spot reaction. There was a large range among clones for all variables, and LSD values were all small relative to the range among clone means. Repeatability was moderate to high for all dollar spot and snow mold ratings. These results demonstrated that there are large and consistent differences among clones for both dollar spot and snow mold reaction.

Gray and Speckled Snow Mold and Dollar Spot
The three populations of creeping bentgrass clones differed for most measures of snow mold and dollar spot reaction. For snow mold, the Wisconsin population had the highest ratings for *T. ishikariensis*, while the Michigan population had the highest ratings for *T. incarnata*. Similarly for dollar spot, the Wisconsin population had nearly the highest mean rating in Wisconsin, the Michigan population generally had mean ratings in Michigan, and the Illinois population had the highest mean ratings in Illinois.

Most snow mold ratings were uncorrelated with each other. The only exceptions were ratings of snow mold reaction and recovery that were taken within a few weeks of each other in either Wisconsin or Michigan. Despite these results, the moderate repeatability of the average snow mold reaction, across all ratings, indicated the presence of some clones with fairly consistent results across all ratings. This is remarkable, particularly given that most snow mold symptoms at the East Lansing, Mich., and Land O' Lakes, Wis., locations were caused by two different snow mold pathogens.

Dollar spot ratings were considerably more consistent across ratings made at different locations or years. This was probably due to the use of a constant source of inoculum at all locations and the fact that dollar spot is caused by only one organism.

In August 2005, four creeping bentgrass clones planted in a research trial on a ryegrass fairway at Gateway Golf Club (Land O' Lakes, Wis.) show differences in genetic resistance to dollar spot.

VALUE AND FUTURE USE OF DISEASE-RESISTANT CLONES

These results suggest that there may be some race specificity for host resistance to these two diseases. Both results are surprising, because studies of host genotypes and pathogen isolates have shown, in both cases, a general lack of host genotype x pathogen isolate interaction.[5,10] These results may be an indication of more long-term evolution of race-specific disease resistance on golf courses, a phenomenon that may not have been detected from evaluation of collections within a limited region. Particularly for snow molds, plants resistant to snow mold from one golf course may not be resistant to snow molds from all other courses. These results underscore the importance of collaboration between researchers at different locations, allowing evaluation of each disease across a wide range of environmental conditions and potential pathogen isolates.

Based on these results, 20 clones with the highest disease indices and superior turf quality were selected for potential release to private companies for use in breeding new varieties of creeping bentgrass. These clones are also being crossed with additional clones with superior dollar spot, snow mold, and brown patch resistance to generate a new set of genetic materials for evaluation and selection.

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This excellent-quality creeping bentgrass plant was selected for resistance to snow mold and dollar spot at Verona, Wis., in August 2005.

Editor's Note: A more complete version of this research can be found at USGA Turfgrass and Environmental Research Online: http://usgatero.msu.edu/v05/n18.pdf.

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CONNECTING THE DOTS

A Q&A with* DR. MICHAEL CASLER, *University of Wisconsin, regarding development of creeping bentgrass with multiple pest resistance.

Q: How common is it for universities located in different states to be cooperatively funded for long-term projects such as the Bentgrass Breeding Consortium? Do you think this is a trend that will increase as funding becomes more competitive?

A: Cooperative funding for long-term projects among universities is very rare. Short-term funding for cooperative projects is more common, usually for two or three years. I don't see this trend changing, as most opportunities for long-term funding have disappeared. In fact, as universities become more competitive, I see this trend continuing. Most of these decisions are made on a case-by-case basis — if the scientists make an excellent proposal, they can be funded, whether at one or more universities.

Q: Do you think grant administrators in most universities are open to interstate teamwork approaches such as yours, or do you feel that they would be reluctant to readily adopt this approach based on current grant funding and reporting procedures?

A: As long as the funding comes from outside the university, I don't think they care one way or the other. Administrators are interested in professors bringing funds into the university and in accomplishing research results. If a collaborative project accomplishes these two things, then it's not viewed any differently. The main impediment is intellectual property, such as improved germplasm — who owns it and who benefits from its development. In our case, this is all shared equally, but it required many months to work out wording that all three universities could accept.

Q: Spreading research dollars over a broad geographic area for a project such as the Bentgrass Breeding Consortium seems to make a lot of sense in that germplasm for multiple resistances can be identified and tested. Are there not-so-obvious drawbacks to this approach, as well?

A: The only drawback we observed was the distances among the collaborators and the difficulty in getting together to discuss the research. Most of these can be overcome by email and professional meetings.

Q: In your research, you focus on germplasm improvement for snow mold and dollar spot resistance in creeping bentgrass. What other resistance(s) do you feel would be priorities for creeping bentgrass, and would this require expanding the number of participating universities in the Bentgrass Breeding Consortium (i.e., a more southern location for bentgrass heat tolerance)?

A: Ideally, we would like to include several other locations, such as Rutgers, Texas A&M, and perhaps some others. This would allow us to cover a wider range of stresses and pests. Complicating this would be two things — introducing more traits to evaluate drastically reduces the probability of success, and adding more collaborators increases the political and administrative problems in creating the consortium and negotiating its rules and boundaries. In the long term, our vision is a nationwide bentgrass breeding consortium, but we feel that it's important to build slowly, rather than try to get everyone on board at once. Funding and organizational limitations are the main reasons for this.

Q: You stated that your objective for the Bentgrass Breeding Consortium is to develop multiple-resistance germplasm in creeping bentgrass. How much feedback have you gotten from seed producers for your germplasm that they could incorporate into new bentgrass cultivars?

A: There is quite a bit of interest among the private bentgrass breeders. However, because the clones have not yet been released to the breeders, they have not been able to provide any feedback at this time. They will have their first access to the clones in spring 2007.

Q: When more resistant germplasm is identified, how soon can superintendents expect it to show up in improved bentgrass cultivars?

A: This process will probably require a number of years to evaluate the clones, incorporate them into new varieties, test the varieties, and conduct seed increases of the new varieties. This process may require a minimum of six to eight years before the first materials reach commercialization.

JEFF NUS, PH.D., *manager, Green Section Research.*

Research *You Can Use*

Mating Disruption of the Oriental Beetle

Rutgers University research demonstrates the potential of using sex pheromones to disrupt mating.

BY ALBRECHT M. KOPPENHÖFER, S. POLAVARAPU, E. M. FUZY, A. ZHANG, K. KETNER, AND T. LARSEN

The oriental beetle, *Anomala orientalis*, is part of a complex of white grub species (Coleoptera: Scarabaeidae) that damages turfgrass throughout the northeastern United States. It has been erroneously considered a relatively minor pest until recently because the adults largely go unnoticed while the larvae of the Japanese beetle, *Popillia japonica*, and oriental beetle are indistinguishable without magnification.

The oriental beetle has become the most important white grub species in turfgrass in New Jersey, southeastern New York, Connecticut, and Rhode Island. It also is the major white grub species in ornamental nurseries and blueberries, and it causes losses in cranberries, strawberries, raspberries, peaches, and sweet potatoes. An increase in oriental beetle significance may occur in other areas where it is already established, i.e., all of coastal New England and the Middle Atlantic states, as well as Ohio, Virginia, North Carolina, South Carolina, West Virginia, and Tennessee.[6,7]

The oriental beetle has a one-year life cycle similar to that of other important white grub species. At the latitude of New Jersey, oriental beetle flight occurs from early June through early August, with peak flight activity typically in late June/early July. The adult beetles live only for about two weeks and do not cause significant damage. After mating, the females lay eggs among the roots of host plants, and the eggs hatch in two to three weeks. The first and second instar each last around three weeks, so that by mid-September the majority of the larvae are in the third instar.[6,7]

Male oriental beetle screening the air for sex pheromone.

After overwintering below the frost line, the third instars resume feeding until pupation in late spring. The extensive feeding activity of the larger larvae can kill large areas of grass from mid-August to mid-October, especially under warm, dry conditions. In addition, vertebrate predators (i.e., raccoons, opossums, skunks, crows) often damage the turf to feed on the grubs.

ORIENTAL BEETLE MATING BEHAVIOR AND CONTROL

Sex pheromone-mediated mate finding and copulation of oriental beetles occur at or near the soil surface, immediately after female emergence from the soil, close to the emergence site.[3,4,5] Males respond to female-released pheromone by a combination of flying upwind and walking short distances. Both sexes are most active between 6 and 10 pm.

Chemical insecticides are still the primary tools for white grub management. However, the implementation of the Food Quality Protection Act of 1996 (FQPA) resulted in the loss of many insecticides for white grub control. Mating disruption with sex pheromones is widely used as an environmentally safe, non-toxic alternative to broad-spectrum insecticides for several moth species.[1]

The sex pheromones of scarab beetles have been studied intensively and are used for monitoring purposes. But only recently has mating disruption technology been considered as a possibility for management of white grubs.

MATING DISRUPTION FIELD TRIALS

To determine the feasibility of mating disruption technology in turfgrass, we conducted field trials with a sprayable microencapsulated formulation of the oriental beetle sex pheromone. Two methods were used to determine the treatment effects on the mating success

or oriental beetles. The first method measured the ability of oriental beetle males to locate a pheromone source similar to a female by determining the number of oriental beetle males captured in traps.

Trapping also was used to monitor oriental beetle male flight and optimize the application timing. The traps were placed in each plot in early June each year, at least 66 feet from the plot's border and any other trap. In 2002, four traps were placed per plot, and septa containing the pheromone were replaced once after four weeks. In 2003 and 2004, three traps were placed per plot, and septa were replaced twice after three weeks of use. Captured males were killed and counted.

The second method estimated oriental beetle larval densities during September, following the applications by taking 30 soil/sod cores (4.25" diam × 4" depth) with a standard golf hole cup cutter in a grid pattern at least 50 feet within the plot's border. Scarab larvae found in the cores were identified to species using the raster pattern. Field plots were situated in turfgrass areas at the Rutgers Research Station in large lawn areas and in golf course rough areas (typically between tee and fairway) in Monmouth County, N.J.

The treatment plots were broadcast sprayed once or twice with microencapsulated oriental beetle sex pheromone using locally available spray equipment. The first spray was applied about 10 days after the first oriental beetle males were captured in traps. Where applicable, a second spray was applied about 14 days after the first spray.

In 2002, one treatment was applied, consisting of two sprays of 20 g ai/acre of a formulation developed by 3M Canada Company (London, Ontario) containing 20% (Z)- and (E)-7-tetradecen-2-one at a 93:7 ratio. In 2003, two treatments were applied, consisting of one spray of 30 g ai/acre or two sprays of 5 g ai/acre of the 3M formulation. Because 3M discontinued the production of its formulation, two

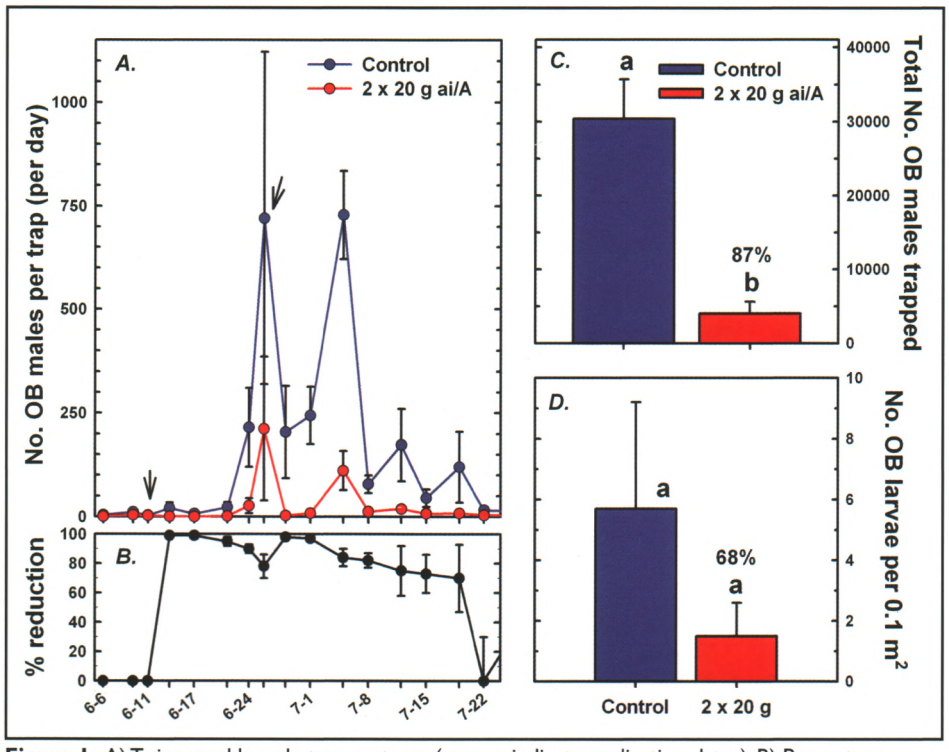

Figure 1: A) Twice-weekly male trap captures (arrows indicate application dates). B) Percentage reduction in twice-weekly trap captures. Arrows indicate pheromone application dates. C) Total seasonal trap captures. D) *A. orientalis* larval densities in September following pheromone application. C, D: means with same letter above bars are not significantly different, and figures above bars indicate percent reduction compared to control.

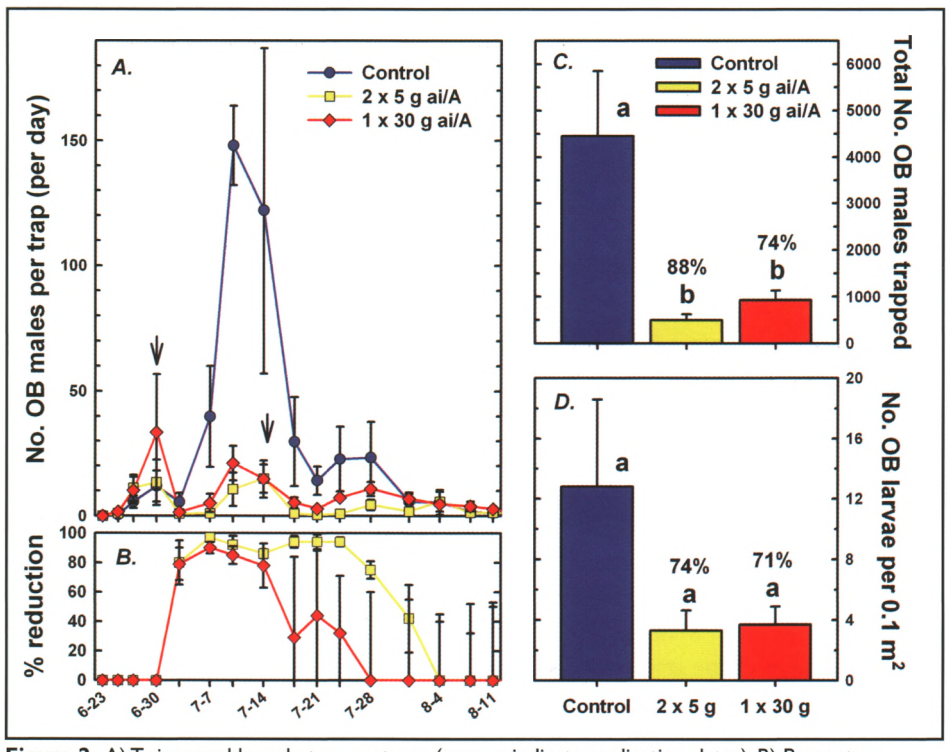

Figure 2: A) Twice-weekly male trap captures (arrows indicate application dates). B) Percentage reduction in twice-weekly trap captures. Arrows indicate pheromone application dates. C) Total seasonal trap captures. D) *A. orientalis* larval densities in September following pheromone application. C, D: means with same letter above bars are not significantly different, and figures above bars indicate percent reduction compared to control.

Suterra LLC (Bend, Ore.) formulations were used in 2004 containing 5.35% (Suterra 03) and 24.11% (Suterra 04), respectively, (Z)-7-tetradecen-2-one, both applied twice at 10 g ai/acre.

RESULTS

Mating Disruption Field Trials

In 2002, oriental beetle male flight started in the first week of June, and trap captures had two distinct peaks on June 25 and around July 5 (Figure 1A). Percent reduction in trap captures (Figure 1B) in the treated plots was 96-100% for the first week after each application, but started to drop during the second week. Total trap captures were 87% lower in the treated plots than in the control plots (Figure 1C). Oriental beetle larval densities in September were 68% lower in the treated plots than in the controls, but due to high variation in the control plots, the reduction was not statistically significant.

In 2003, oriental beetle male flight started in the last week of June after an unusually cool spring (Figure 2A). Percent reduction in trap captures (Figure 2B) in the treated plots was 96-100% for the first week after each application, but started to drop during the second week. Total trap captures were significantly lower in the 1 × 30 g ai/acre treatment (74% reduction) than in the control, and they were significantly lower in the 2 × 5 g ai/acre treatment (88% reduction) than in the 1 × 30 g ai/acre treatment (Figure 2C). Oriental beetle larval densities in September were 71-74% lower in the treated plots than in the controls, but due to high variation in the control plots, the reduction was not statistically significant (Figure 2D).

In 2004, oriental beetle male flight started in the first week of June, had an extended peak between June 17 and July 5, and continued elevated activity until about July 20. Total trap captures were significantly lower for the Suterra 03 (68% reduction) and Suterra 04 formulations (70% reduction) (both applied at 2 × 25 g ai/acre) compared to the untreated control. The effect of the pheromone started to decline in the second week after each application. Due to the high variation in larval densities, there were no significant differences among treatments.

Shoes used to walk through pheromone-treated areas one day after treatment were sufficiently contaminated with pheromone to attract high numbers of oriental beetle males in non-treated areas.

Effect of Post-Application Irrigation on Pheromone Adherence to Grass Blades

After spray application, a significant amount of oriental beetle pheromone may remain on the grass foliage, rather than drip off into the thatch and soil. Removal of grass clippings from mowing could then reduce the efficacy of the pheromone application. To determine whether post-application irrigation is necessary to wash the pheromone off the foliage and into the thatch and upper soil layers, areas were sprayed with 30 g ai/acre of the 3M formulation and overhead-irrigated with 0", ⅛", or ¼" after treatment. The grass was then cut just above the thatch surface, collected, and the pheromone extracted. The amount of pheromone in the clippings extract was determined with gas chromatography-mass spectrometry. In samples taken directly after application, significantly less pheromone was detected in clippings taken from plots watered with ⅛" and ¼" than in the non-watered plots. No pheromone could be detected in samples taken after seven days.

Adsorption of Sex Pheromones to Shoes

Oriental beetle pheromone can adsorb to surfaces with which it comes into contact, such as shoes. These can then attract male oriental beetles over an extended period of time. To test whether shoes can be contaminated with enough oriental beetle pheromone to cause a potential nuisance to golfers, one pair of athletic shoes was walked through each of the areas treated with oriental beetle pheromone, for 30 minutes at one or eight days after treatment. From each pair, one shoe was used for pheromone extraction, the other in a bioassay.

In the bioassay, the shoes were lined up on the surface of a non-pheromone

treated turfgrass area in a continuous line of three groups, with each group containing one shoe from each treatment and a non-pheromone exposed shoe. Oriental beetle males were collected from the shoes for 45 minutes. No males were attracted to the control shoes. Significantly fewer males were attracted to shoes walked at eight days after treatment (average 1.8; range 0-10) compared to shoes walked at one day after treatment (average 42.3; range 6-81).

The shoe not used in the bioassay was rinsed with acetone for 10 minutes, and the amount of pheromone in the extract analyzed by gas chromatography. From shoes walked one day after treatment, 62.1 ± 15.3 µg per shoe were detected. No pheromone was detected on the shoes walked eight days after treatment or on the control shoes.

Traps containing sex pheromones are used to monitor the male oriental beetle flight pattern.

CONCLUSIONS

This study demonstrates the feasibility of mating disruption in the turfgrass system. However, the effect of the pheromone spray started to wane after about 10 days, making necessary a second application after 14 days. Due to the inherently high variability of white grub populations within and among turfgrass sites, the larval counts in our experiments, particularly in the non-treated areas, were too variable to allow for the detection of statistically significant differences. Nevertheless, the trend in the 2002 and 2003 field seasons using the 3M formulation was very consistent, with 68-74% lower oriental beetle larval populations in the treated areas.

The efficacy of mating disruption using sprayable formulations could be improved with more frequent applications, probably even with lower pheromone application rates than used in this study. However, the availability of insecticides that are highly effective and require only one seasonal application (i.e., imidacloprid, clothianidin) will limit the acceptance of mating disruption unless a formulation can be developed that is more effective and/or requires only one seasonal application. We don't believe that this goal can be achieved using microencapsulated sprayable formulations. In addition, the potential contamination of shoes and other clothing articles by the sprayable formulation and the ensuing attraction of male beetles to these articles outside of treated areas present a drawback of these formulations.

Dispersible pheromone formulations consisting of numerous broadcast small pheromone sources or fewer larger sources may solve the problems of limited persistence as well as contamination of clothing articles in the turfgrass system. Our ongoing studies with dispersible formulations suggest that mating disruption can be an effective, safe, environmentally and economically sound, easily implemented, durable, and highly IPM-compatible option for oriental beetle management in turfgrass.

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CONNECTING THE DOTS

A Q&A with* ALBRECHT KOPPENHÖFER, PH.D., *associate professor and extension specialist, Rutgers University, on the mating disruption of the oriental beetle.

Q: What other crops have benefited from mating disruption technology of their insect pests? Have producers of those crops readily accepted mating disruption as a primary means of managing insect pests of those crops?

A: Mating disruption has been used for a long time in orchard systems (e.g., apples, pears, peaches) for the control of various moth species (e.g., codling moth, oriental fruit moth), but it is also used in cole crops (diamond back moth), tomatoes (tomato pinworm), and forestry (gypsy moth). Mating disruption is widely used in many of the above systems, sometimes as the primary means of controlling a pest, often as an important component of Integrated Pest Management that does not disrupt biological control and reduces the chances of development of insecticide resistance in pest species.

Q: If mating disruption technology for turf insects proves feasible, are there specific requirements for storing and using insect sex pheromones, or would they be formulated in such a way that storage conditions would not be an issue?

A: Storage of sex pheromone products should be non-problematic with similar minimum requirements as for synthetic insecticides and good shelf life.

Q: As you know, some municipalities in the U.S. and Canada have banned the use of turfgrass pesticides. Do you feel that the use of mating disruption may prove to be an acceptable alternative strategy for control of white grubs in those locations?

A: Mating disruption could certainly be an acceptable alternative to insecticides for white grub management. However, since mating disruption generally is only effective if used over larger areas (at least one acre, better for several acres), its use would have to be coordinated in a more area-wide approach for landscape situations. On golf courses this requirement should not be difficult to meet.

Q: One of the primary considerations that superintendents have in considering pest control strategies is cost, especially on golf courses with limited maintenance budgets. If mating disruption technology proves feasible in turfgrass, how do you think the cost of this strategy would compare with conventional use of insecticides?

A: On a per-acre basis, mating disruption should be cheaper than many of the newer insecticides. If used in a more area-wide approach such as on large areas of a golf course, the cost may become higher. However, it is likely lower, and with that even less expensive rate would be effective if used in larger areas.

Q: Are sex pheromones used for mating disruption federally regulated in ways similar to the ways (e.g., FIFRA, FQPA) that conventional pesticides are regulated? If not, would you expect them to be?

A: Sex pheromones are regulated by FIFRA, but the requirements are less strict than for conventional insecticides.

Q: In your opinion, what would it take for the golf course industry to accept mating disruption as a primary means to control certain insects?

A: Cost and efficacy similar to that of available synthetic insecticides. Lack of safe and/or effective synthetic insecticides would, of course, lower the bar considerably.

JEFF NUS, PH.D., *manager, Green Section Research.*

Editor's Note: A complete report of this study can be found at *USGA Turfgrass and Environmental Research Online*: http://usgatero.msu.edu/v05/n09.pdf.

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Water Quality Testing — The Agony and the Ecstasy

It's not difficult to test the water on a golf course, and the knowledge gained can be valuable.

BY SAM FRIED

Several years ago, when my hometown of Bloomfield, Conn., decided to build a golf course on an old farm property, the town engaged my services to do a wildlife census to monitor the environmental impact of the course. The farm was on a beautiful piece of land, with several extensive wetlands, a small Army Corps of Engineers flood control reservoir, an irrigation pond, open meadows, and upland second-growth forest. The course was constructed with the aid of an environmental consultant to ensure that the highest standards of care were employed to protect the natural habitats on and around the layout. Once the course was completed and management was turned over to Billy Casper Golf, Inc., they in turn hired me to continue the project and take the additional step of having the course certified in the Audubon Cooperative Sanctuary Program (ACSP).

My background as an expert birder and semi-knowledgeable naturalist allowed me to document the wildlife over a two-year period, finding 153 species of birds, 19 mammal species, and numerous insects, reptiles, and amphibians. I carefully followed the ACSP for Golf Courses guidelines and enjoyed working through the certification requirements for the Site Assessment, Environmental Case Study, Wildlife and Habitat Management, Chemical Use Reduction and Safety, and Outreach and Education categories. But when it came to Water Quality Management, I ran into a wall.

The LaMotte kit can be purchased from a variety of suppliers, including LaMotte, Ben Meadows, Carolina Biological Supply Co., Forestry Suppliers, SK Science Kit & Boreal Labs, and others. The kit costs approximately $350 and contains supplies for 50 tests of the various types necessary to perform the water quality assessment required for certification.

Water quality monitoring is easier and more fun when you have someone to assist you. Marlee Forsthoffer assisted with checking the water samples at Wintonbury Hills Golf Course.

WANTED: CHEMIST, NO PREVIOUS EXPERIENCE REQUIRED

We had taken careful steps to employ Best Management Practices around the course to protect the local watershed and water sources. But when it came time to actually test the water on and around the course, the task seemed daunting. My previous experience in chemistry was in high school, limited to sticking a piece of litmus paper into a tube of some unknown liquid, for reasons I can't recall. I told myself I couldn't possibly do the complex tests that were required for certification!

I contacted the University of Connecticut about having some agronomy students do the testing as part of their curriculum. After many months of correspondence and delays, there were no takers. I asked the State of Connecticut if they could do the testing. Not interested. I wrote to the Environmental Consultant. No help. In desperation, I again contacted Shawn Williams, staff ecologist at Audubon International, who recommended that I purchase a LaMotte "Water Quality Educator Monitoring Outfit" and do the monitoring myself.

When the package arrived, it contained an impressive-looking black case lined with molded material to hold in place all of the test kits, tubes, measuring devices, chemicals, pills, and reagents. There also was a separate plastic jar, filled with cellulose, gently holding a bottle of sulfuric acid that contained warnings as to the horrors that might befall the user if proper precautions were not taken. The book of instructions, at first, seemed much too large and complex for my meager abilities, but then I slowed down and took a careful look. Each test kit (dissolved oxygen, pH, alkalinity, phosphates, nitrates, turbidity, temperature) contained its own set of instructions and was written in comprehensible English. Perhaps I could do this testing after all.

WADING IN

I was fortunate to have an assistant working with me, Marlee Forsthoffer, an Environmental Studies student at Nova Southeastern University in Florida. Between the two of us, we managed to go carefully through each test. Only once did we misunderstand the directions and ruin the test, and the error was easily corrected. In fact, after the first set of tests on the irrigation pond, we repeated them on the reservoir in about one-half the time. After the initial run, we determined that each set of tests can be performed in about one hour.

We wore protective eyewear and rubber gloves when handling the caustic chemicals, and we took turns wading in for water samples, collaborating on how to evaluate the results. It was helpful to have two people doing the testing, as one of us would carefully read the directions while the other worked with the materials. It actually turned out to be a lot of fun once we got the hang of the test procedures. I always liked the "magic" of making a purple tube of liquid suddenly go clear with a few drops of some reagent, making me feel like I was "Mr. Wizard" on the TV program of my youth.

Many of the tests were fairly straightforward, while others were more complicated. The key was to follow the directions to the letter and then record the results on a test chart made up for the specific site.

EVALUATING THE RESULTS

Although every body of water will produce different test results, it is very useful to learn about the baseline conditions at the course and the effect of implementing Best Management Practices on overall water quality. The numbers from our in-and-out irrigation holding pond were quite different from those of the small stream-fed reservoir, but everything, except phosphate levels, were within acceptable limits.

Evaluating the results has to be done with consideration of prior land uses. For example, this golf course was a heavily fertilized farm for 100 years, probably accumulating significant amounts of nitrates and phosphates in the soil over that time. This would likely account for high test levels that have little to do with course management. Learning the history of your site can be very important in obtaining an accurate picture of the test results.

How do I rate the overall experience? Surprisingly fun! So if you're timid about water testing, I recommend you get yourself a test kit, put on some rubber boots, and wade right in. It's easier each time you do it, and the knowledge you gain can make your course a better place to live for the plants, creatures, and people that make it their home.

SAM FRIED *is the golf course naturalist at Wintonbury Hills Golf Course in Bloomfield, Conn. He can be reached at magesfried@aol.com.*

2007 USGA Green Section Education Conference Golf Industry Show

Friday, February 23, 2007
10:15 am - 12:00 pm
Anaheim, California

MYTHS, FADS, AND FALLACIES: THEIR IMPACT ON THE GAME

Moderator:
MATT NELSON, *Senior Agronomist, USGA Green Section Northwest Region*

The Best Turf Tips
BOB VAVREK, *Senior Agronomist, North-Central Region*

Accommodating People with Disabilities — Staying Out of Court and Making Money in the Process
MARTIN EBEL, *General Counsel, Massachusetts Commission Against Discrimination*
What the law says regarding disability issues on the golf course, and how you need to deal with it.

Presentation of the 2007 USGA Green Section Award
JIM SNOW, *National Director, USGA Green Section*

More of the Best Turf Tips
PAT GROSS, *Director, Southwest Region*

Ball and Club Rules — Are Any Changes Needed?
DICK RUGGE, *Senior Technical Director, USGA Test Center*
A discussion of opinions and facts about the impact of golf equipment on the game.

The Best Turf Tips Keep On Coming
LARRY GILHULY, *Director, Northwest Region*

Preparing for Golf at the Championship Level
MIKE DAVIS, *Senior Director, USGA Rules & Competitions*
Nothing receives more notice than the condition of the golf course during a U.S. Open, one of the toughest tests in golf. The facts about how golf course preparation has changed over the years.

The Best Turf Tips Aren't Done Yet
CHRIS HARTWIGER, *Senior Agronomist, Southeast Region*
DAVID OATIS, *Director, Northeast Region*

2007 USGA NATIONAL & REGIONAL CONFERENCES

National Conference

February 23	Anaheim Convention Center Anaheim, California

Florida Region

January 4	Boca West Country Club Boca Raton, Florida

Mid-Atlantic Region

March 5	Radisson Hotel/Expomart Monroeville, Pennsylvania
March 13	Woodholme Country Club Baltimore, Maryland

Mid-Continent Region

January 31	Overland Park Convention Center Overland Park, Kansas
March 19	Trophy Club Country Club Trophy Club, Texas

Northeast Region

March 6	Rhode Island Convention Center Providence, Rhode Island
March 21	Willow Ridge Country Club Harrison, New York

Southeast Region

March 13	Pine Needles Lodge & Golf Club Southern Pines, North Carolina

Northwest Region

March 6	Holiday Inn Missoula, Montana
March 13	Lakewood Country Club Lakewood, Colorado
March 19	Tacoma Country & Golf Club Tacoma, Washington
March 26	Waialae Country Club Oahu, Hawaii
March 27	Wailua Golf Club Kauai, Hawaii
March 28	Hapuna Golf Club Big Island, Hawaii
March 29	Kahili Golf Club Maui, Hawaii
April 23	Waverley Country Club Portland, Oregon

Southwest Region

January 8	Tustin Ranch Golf Club Tustin, California
March 12	Castlewood Country Club Pleasanton, California

North-Central Region

Fall	TBA

Quit Fooling Yourself

Are you really accomplishing anything by dusting the greens with ultra-light applications of sand?

BY BOB VAVREK

Golfers are raising the bar every year regarding expectations for firm, fast, smooth greens. One of the more common complaints heard in recent years is, "The superintendent constantly overwaters and the greens are wet, soft, and bumpy, and the ball marks pit into the surface."

Why are greens spongy? The most common condition is excessive accumulation of organic matter in the upper soil profile. Healthy turf constantly recycles organic matter into the soil when roots, shoots, stolons, and other plant parts are replaced throughout the growing season. Soil microbes decompose the plant debris, but it can accumulate rapidly when the rate of organic matter production exceeds the rate of decomposition.

A soil physical testing lab can quantify the percentage of organic matter, but as they say here in the Dairy State, "you don't have to open up the package to know there is limburger cheese inside." When you have it in greens, either you know it or you are in denial. Cut a wedge of turf and you can see a dark accumulation of peat-like material at the surface. You can squeeze water from the dark layer, even though you haven't irrigated the greens recently.

Many factors tip the scales in favor of excessive organic matter accumulation. They include overwatering, excessive fertilization, a wet/cool climate, and the use of modern, ultra-dense cultivars of bentgrass or bermudagrass.

Sometimes it's what you don't do that contributes to thatch buildup. A topdressing program that fails to keep pace with organic matter accumulation is often the cause of soft, wet greens.

It's hard to acknowledge a thatch problem when you are topdressing more than ever. You may be using a walk-behind fertilizer spreader to dust greens with sand every week. Perhaps you have a state-of-the-art spinner spreader and religiously topdress greens every two weeks from spring through fall because you can knock off six putting surfaces at a time before returning to the shop for another load of sand. A spritz of water from the irrigation system and *presto*, the sand disappears into the playing surface. Life is good . . . the mowers stay sharp and you are, in fact, topdressing more than ever. "How in the world can I have a thatch problem when I topdressed my greens 28 times this year?"

Here lies the rub. It's not how many times you apply sand to greens that determines the effectiveness of your thatch management program; it's how much sand is being applied to the greens that makes all the difference. Sure, you are topdressing more often, but you are still not keeping pace with organic matter accumulation.

In olden days (20 years ago), you had limited options for topdressing equipment. Vicon or Lely fairway fertilizer spreaders often doubled as topdressing units. State of the art was a smooth belt/brush Mete-R-Matic that did a great job filling those big ⅝-inch coring holes in greens with sand every spring and fall, but it couldn't be dialed back enough to apply light rates of sand (which was always wet) across greens. In fact, all the equipment available for topdressing basically dumped a lot of sand on the surface, and that wasn't all bad.

The amount of sand applied to greens easily kept pace with organic matter accumulation, and all it took was a few additional topdressings sandwiched between spring and fall coring operations. This uniform zone of topdressing can still be visible below the dark layer of organic matter accumulation in many old greens. Unfortunately, the topdressing and cultivation train has jumped the track at many courses.

Getting back on track won't be easy, because eliminating thatch is a disruptive process, and the disruption is why unreasonable and uninformed golfers have denied some superintendents the opportunity to manage the greens properly in the first place. It's amazing how many courses have suspended ½- to ⅝-inch hollow-tine coring operations in favor of less-disruptive cultivation, such as solid deep-tine or ¼-inch hollow-tine coring.

Addressing this problem may be as simple as adjusting modern equipment to apply more sand per application. And, yes, hollow-tine core cultivation needs to be an integral part of the greens maintenance program every year.

Old greens have been pushed to their limits and beyond to provide golfers firm, fast, smooth greens for day-to-day play. Cut back on topdressing and coring operations and you will have soft, wet, bumpy greens. We are all fooling ourselves if we think we can continue to accumulate thatch on greens and still produce a high-quality putting surface.

BOB VAVREK *doesn't fool around when it comes to making recommendations regarding topdressing and cultivation on Turf Advisory Service visits in Michigan, Minnesota, and Wisconsin.*

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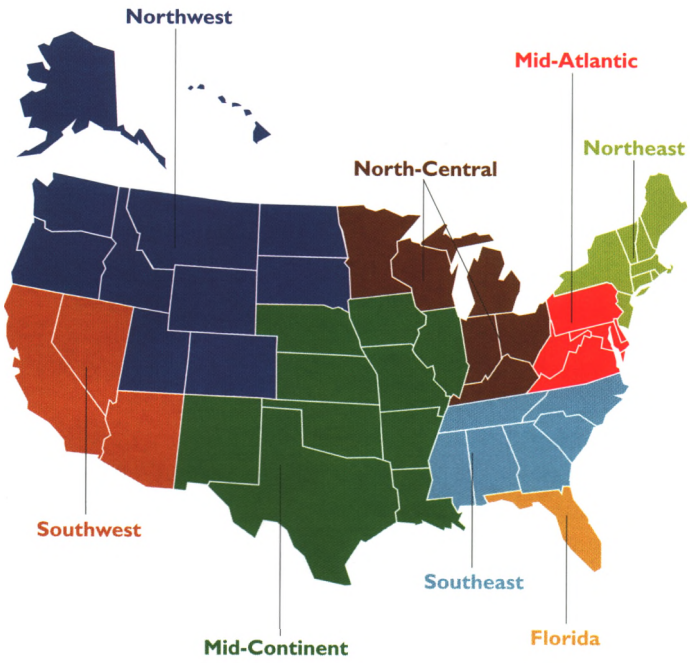

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Turf *Twisters*

Q: With each passing year it seems as though the pressure to schedule core cultivation on the greens in mid-March gets stronger and stronger. In my position as the golf course superintendent, putting together a convincing argument in opposition to this request is difficult in that other courses in the area are aerated soon after the ground thaws in spring. Does the USGA have any advice regarding scheduling this practice during the first half of the growing season? (Kansas)

A: Core cultivation creates a void in the turf canopy, so scheduling this practice too early in the year has several disadvantages. First, with the likelihood of cold temperatures prior to mid-April in the Midwest, the turf will exhibit slow recovery from any practice that causes significant surface disruption. Second, if the greens are creeping bentgrass, creating open holes in the canopy at times when it is not growing vigorously creates an opportunity for *Poa annua* germination and establishment. Lastly, early scheduling diminishes the benefit of improving water infiltration during early summer. With so many disadvantages coming into play, it would be best to avoid playing follow-the-leader with neighboring courses and instead schedule core cultivation in late April or early May.

Q: Our greens are mostly *Poa annua* and we have a few members who are speed freaks and believe that verticutting is the only way to get it. How often should greens be verticut without putting undo stress on them? (Connecticut)

A: Verticutting utilizes a mechanical device with vertically rotating blades that cut into the turf surface to remove excess thatch or leaves, depending upon how deep the blades are set. Verticutting can have a positive influence on putting green firmness, as well as trueness and ball roll distance. It is not uncommon to verticut greens several times during a week in the spring or late summer when shoot growth is most active and environmental conditions are less stressful on the turf. Be cautious about verticutting during or preceding stressful periods of the season, when the turf can be weakened and then predisposed to attack from diseases or other pests. Verticutting is not the only practice that influences ball roll. Lightweight rolling and light, frequent sand topdressing can help improve surface smoothness and ball roll without compromising turf health. The old adage "everything in moderation" definitely applies to practices aimed at increasing green speed.

Q: Why does our superintendent recommend keeping carts on the path and off the fairways in the winter even though the course is dry? (Alabama)

A: The bermudagrass on your golf course cannot repair itself from traffic during the times of the year when it is dormant (brown). Keeping carts on the path helps to minimize the beaten-down, worn-out appearance so often associated with bermudagrass fairways in late winter. Keeping carts on the path in the winter rewards the golfer with more "cushion" underneath the ball.

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