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OLD PROBLEMS, NEW CHALLENGES

Contents

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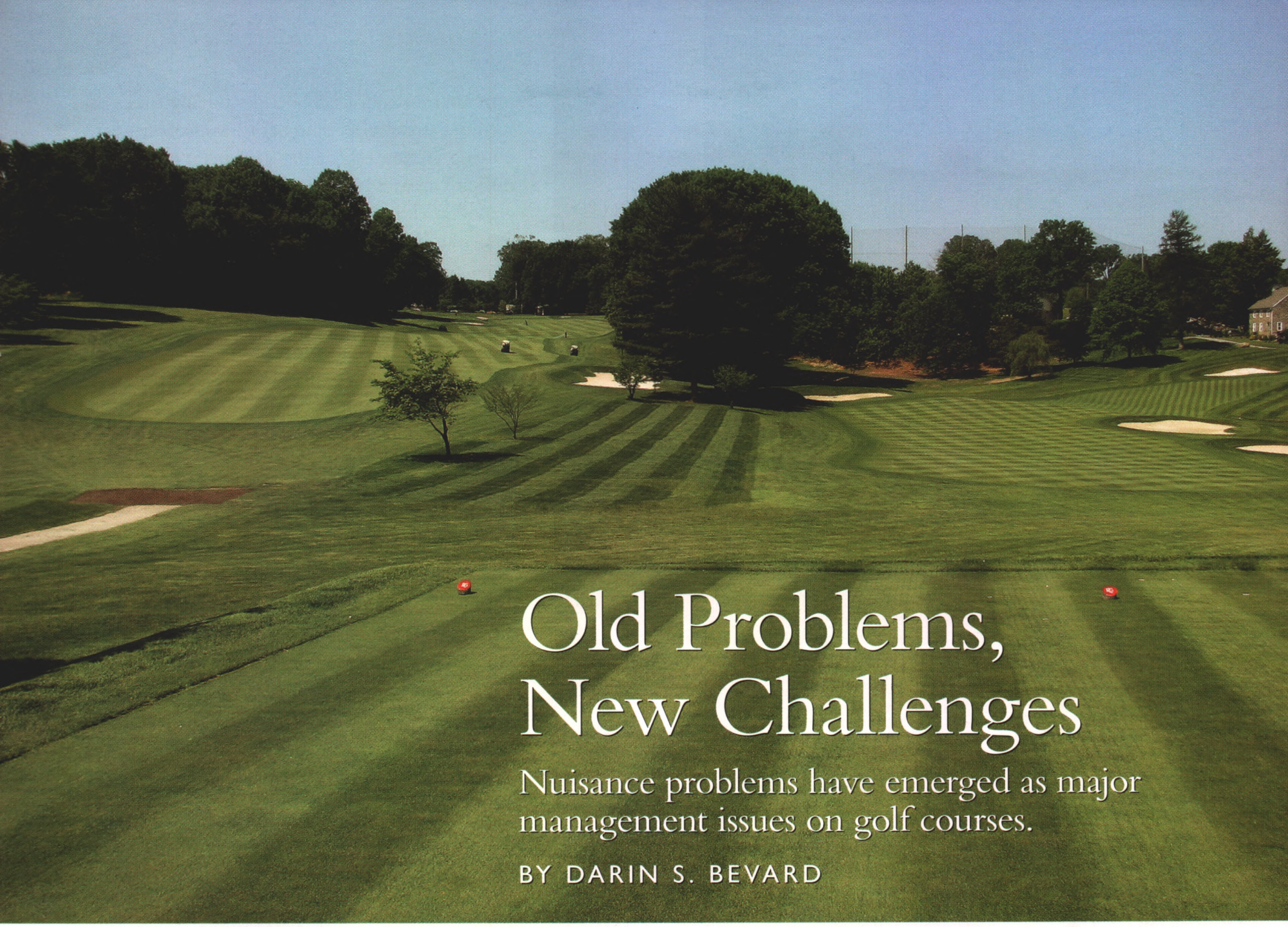
Cover Photo
What used to be nuisance ant mounds has now emerged as a much larger management issue on golf courses.



Old Problems, New Challenges

Nuisance problems have emerged as major management issues on golf courses.

BY DARIN S. BEVARD

The intensity of maintenance at higher budget golf courses has created a standard whereby any blemish is easily noticed. Maladies that may have been present in the past, but went unnoticed by golfers because turf quality was inferior, are now easily picked out.

Challenges for turfgrass maintenance have been a constant in the golf course industry since its beginnings. In recent years, maladies that used to be viewed as nuisances, curiosities, or annoyances have emerged as full-blown turf management issues. Major turfgrass problems still occur on golf courses, but more time seems to be spent dealing with these "little problems" than ever before. The increase in these problems coincides with increasing golfer expectations, but golfer expectations alone cannot explain why these problems have emerged. Although everything is relative, golfer expectations have always seemed to trend toward the high end of the conditions that *can* be maintained on golf courses. Interestingly, some of these problems are some of the most difficult to control and explain. Certainly, the emergence of these problems is complex and likely the result of multiple management factors.

Diseases such as fairy ring have occurred more often or at least have garnered more attention in recent years. This disease has created aesthetic and playability nightmares on many golf courses. Cultural and chemical treatments are very effective or else completely ineffective, depending upon factors that are not completely understood. More research is being conducted to better understand fairy ring because of its emergence as a significant turf problem. Soil diseases such as root Pythium dysfunction and take-all patch are difficult to control once they are active. Creeping bentgrass collars decline uncontrollably during the heat of summer. In some instances, more conservative maintenance practices in conjunction with intense fungicide programs provide little relief.

Localized dry spots (LDS) seem more prevalent than ever during any periods with below normal rainfall, requiring more hand watering. Earthworms and ants cause turfgrass damage through casting and mounding of soil that create major issues with playability, appearance, and maintenance. Earthworm control is

Inconsistent dew patterns may be an early indicator of localized dry spot. Localized dry spots create water management challenges that require frequent hand watering to prevent turf decline. This condition has become more of an issue in recent years as management practices have changed to meet golfer expectations.

illegal and controlling nuisance ants in fine turf areas is an ongoing battle.

These are just a sampling of some old problems that have emerged as major challenges in everyday turfgrass management. If we could truly define the root cause of these issues, maintenance programs could be changed to limit their impacts on turf quality. Unfortunately, pinpointing a single reason why these problems have emerged is extremely difficult. Of equal frustration is trying to explain why these problems occur on some golf courses, or even specific areas of an individual golf course, but not on others, in spite of maintenance programs and other factors that are summarily the same. There are many variable factors that may contribute to these problems. This article will not serve to define control options for these issues. Rather, it will explore some of the changes that have occurred in turfgrass management that may help to explain the emergence of these problems, helping to mitigate their impacts or at least allow some acceptance of these maintenance challenges.

GRASS SELECTION

Grass selection for golf courses plays a role in these "new" problems, especially in the transition zone regions of the country. As our ability to provide excellent playing conditions with cool-season grasses in warmer climates has improved, these grasses have been pushed into regions that provide tremendous challenges during times of summer stress. Creeping bentgrass varieties for putting greens, especially, have been pushed into difficult areas with expectations that cannot be provided. The idea that perfect playing conditions can be maintained during times of the growing season when survival of the grass is a better goal is not realistic. Technological advancements cannot overcome physiological limitations of the turfgrass under certain conditions, yet we often expect them to. Increased management intensity on grasses that are pushed to geographical limits during periods of maximum environmental stress creates a potential opportunity for even weak pathogens and pests to create major turfgrass problems.

CHEMICAL CHANGES

Chemical pesticide options that are available for use on golf courses are more numerous than ever. Our understanding of how these chemicals work is more complete because the screening process for their registration is more stringent. However, many of our commonly used chemicals have site-specific modes of action that target specific insect or disease organisms. Many insecticides currently used on golf courses are only effective on a specific growth stage in the life cycle of an insect pest, so timing is critical. Non-target effects are minimal compared to older chemistries; persistence in the soil of contact insecticides is short, and some are tightly bound to organic matter, which may further reduce potential non-target activity. Broad-spectrum activity, high toxicity to target pests, and long soil residual are a strong combination to provide good pest control for a long time. Most of our existing insecticides lack this combination of characteristics.

Earthworms are an indicator of healthy soil and provide many benefits for the turf. However, earthworm castings play havoc with maintenance and playability. In the case of earthworm development, earthworm suppression was a side effect of insecticide products that are no longer available. One specific example is the insecticide chlordane. Chlordane and related compounds were very effective against a wide variety of targeted insect pests and some non-target organisms, including earthworms. The mean half-life of chlordane (the time at which half of the chemical degrades in the soil) is reported by the EPA to be 3.3 years. Half-life of chlordane varies by soil type because it is tightly bound to soil particles. Thus, a single application of chlordane could provide residual control of soil-borne pests for several years. Frequency of application varied by the pest targeted. If chlordane was applied every other year in a five-year period, prior to application in the fifth year of application, soil residual would be slightly higher than the initial rate of application. With the year five application, the residual in the soil would be double the initial application rate. Depending upon the interval and rate of application, chlordane could remain in the soil at rates high enough to maintain continuous control of various pest problems.

Other insecticides that research showed to be toxic to earthworms, including bendiocarb (Turcam) and ethoprop (Mocap), have been discontinued for use on turf. Research has shown that one of the side effects of insect control applications with these products was earthworm suppression.

Similarly, the elimination of mercury compounds and other fungicide products has changed disease control, especially for some of our hard-to-control diseases such as take-all patch. Mercury provided control options for a lot of diseases with a single product, with little chance for resistance. The elimination of these compounds may be partly responsible for the surge in fairy ring problems on golf courses over time as well.

The discontinued use of all of these products for the betterment of the environment was a positive step for golf courses, but it is likely that side effects of some of those products helped to control non-target problems. The removal of those products from the market is one factor in the emergence of some of the problems that we are now experiencing.

IRRIGATION PRACTICES

Wall-to-wall irrigation coverage on golf courses is becoming more of a standard than a luxury. Frequency of irrigation has increased on most golf courses in the past 20 years. Irrigation of the near rough and green surrounds is considered a must on many golf courses. Increased irrigation has improved the appearance of fine turf areas, but could our penchant for green turf, in combination with firm, fast conditions, be contributing to some of the persistent problems that are being experienced at certain times during the growing season?

Cool, moist soil conditions certainly encourage earthworms and provide a perfect environment for casting activity. Irrigation prolongs these conditions for earthworm development. Our irrigation practices may also encourage other problems such as fairy ring and LDS.

Fairy rings take on various appearances in turf. Sometimes, only superficial symptoms are expressed as a dark green ring of turf. This is caused by nitrogen release during the breakdown of organic matter as the fungus develops. Sometimes, the rings are only annoying aesthetically. Other times, the turfgrass at the edge of the ring declines because of excessive nitrate release under high temperatures. More commonly, water repellant soils develop and create drought stress on the turf around the rings.

Severe fairy ring can kill grass in spite of fungicide applications. Killer fairy ring has been more common in recent years, possibly fueled by irrigation and other management practices that encourage its development over time.

The basidiomycete fungus that is the main cause of fairy ring thrives under moist conditions, as do most fungi. Many golf courses irrigate turf on a frequent basis, and this maintains an environment in the upper portion of the soil profile that aids in development of fairy ring and other diseases. Massive fairy ring development has been noted after heavy rain, again pointing to the importance of water in development of this problem. Under dry weather conditions, irrigation inputs keep the grass green but are not adequate to prevent wilt stress from occurring in the turf as a result of fairy ring.

Deep, infrequent irrigation is often the goal of irrigation cycles, and this provides benefits in terms of playability and disease prevention. Irrigation is applied heavily to thoroughly wet the soil, and the soil is then allowed to dry down before additional irrigation water is applied. Unfortunately, research suggests that LDS is encouraged partly by repeated wetting and drying cycles. With each drying cycle of the soil, organic acids coat soil particles and this eventually leads to hydrophobic conditions. Again, some of our accepted management practices may have some unintended consequences when they are implemented as the season progresses.

GOLFER EXPECTATIONS

The common denominator that brings together all of the above issues is golfer expectations. The goal of any turfgrass management program is to meet the expectations of golfers while maintaining aesthetically pleasing surfaces. Golfer expectations are as high as they have ever been, and this is not a complaint or an excuse; it's a fact. It may come as a surprise to some that many of the maintenance programs that are used on golf courses are a compromise between keeping the turfgrass alive and providing the conditions that golfers expect and demand. Changes in irrigation practices mentioned above are directly related to expectations, and there are other logical relationships between golfer expectations and the emergence of many turfgrass maintenance problems.

Most golfers agree that the appearance and playability of golf courses are more uniform and consistent than they were in the past. Thus, when blemishes do occur, regardless of the cause of the problem, they are more noticeable. When problems are noticed, solutions to cure them are sought. Some of these problems may have been ignored or tolerated in the past, but not anymore. At the same time, these problems are often at their worst at the times of the growing season when the turf is least able to tolerate additional stress. Consider that five percent turf loss spread around a putting green would yield a surface considered unplayable by the modern golfer. This simply indicates the level of quality maintained today.

Low mowing heights also are a contributing factor, causing great physiological stress on the turf. With less leaf tissue, photosynthetic capacity and thus recuperative potential is reduced. Higher-cut turf can mask problems that are so noticeable in fine turf areas. For example, ants and earthworms live in golf course rough just as

Earthworm casts create challenges for mowing and playing quality. Heavy earthworm casting can turn fairways to mud in a matter of days. Peak casting activity in spring and fall also coincides with peak golfer activity, which highlights the damage that occurs and the frustration that comes with it.

As height of cut has been reduced on fine turf areas, problems such as nuisance ant mounds are all the more noticeable in terms of playability. They cause more injury to the turf because lower-cut turf is easily smothered by ant mounds.

happily as they do in tees and fairways. However, ant mounds and worm casts have little impact in 3-inch Kentucky bluegrass rough compared to creeping bentgrass fairways mowed below one-half inch.

Nitrogen fertilizer rates often are kept low in an effort to promote green speed, which makes the grass more susceptible to diseases such as anthracnose. Water is withheld to produce firmer conditions, but doing so may further stress the grass. Greens are mowed and rolled more frequently, placing additional mechanical stress on the turfgrass. The decline of collars that is frequently experienced during the summer months is directly related to traffic intensity from equipment used to prepare greens for daily play.

These practices can jeopardize turfgrass health at any time of the year, but they are especially damaging when environmental stresses are high. Sometimes, brown grass provides excellent playability, but there is an expectation for golf course presentation that often overrides playability. This desire for green turf is often in direct conflict with playability goals set forth by green committees and course officials. Firm, fast, and green are difficult to achieve, especially during the most stressful portions of the growing season. The result is turfgrass that is under tremendous physiological stress; that is less able to resist disease, insects, etc.; and that is less able to recover from damage that occurs. The closer the grass is to "the edge," the more susceptible it will be to pathogens that may not otherwise be a problem. Interestingly, some of these problems that are a major issue on very intensely managed golf courses are nothing more than a passing interest on lower-maintenance golf courses that do not have the resources to push grasses to their limits. Expectations are lower at these facilities, and with the exception of problems on putting greens, problems with LDS, earthworms, fairy rings, etc. are ignored or at least accepted.

No single factor is to blame for the emergence of old problems and the development of new ones as major management challenges. The loss of certain pest control chemistries has affected control of diseases, insects, and other organisms, such as earthworms, and has challenged the resourcefulness of superintendents and agronomists to develop solutions. The level of maintenance provided on golf courses, especially as it relates to irrigation, has allowed better turfgrass quality to be maintained, but it may also provide a better environment for some emerging problems to persist. For sure, golfer expectations have created a heightened awareness of certain issues on fine turf areas. Maintenance challenges of one kind or another have always existed on golf courses, and we must continue to develop strategies to meet these challenges and keep up with the ever-changing expectations of golfers.

Darin S. Bevard *is a senior agronomist in the Mid-Atlantic Region of the transition zone, which is fertile ground for the emergence of management challenges.*

Long-Term Monitoring of Nutrient Loss in Runoff from a Golf Course

A one-of-a-kind investigation at Colbert Hills Golf Course documents effects before, during, and after construction.

BY STEVE STARRETT, YUNSHENG SU, TRAVIS HEIER, JAMIE KLEIN, JEFF HOLSTE, AND MONICA PALOMA

OBJECTIVES

- Compare nutrient loading via surface water runoff from a new golf course versus the site's previous native prairie condition.
- Investigate the new golf course's impact on surface water quality during construction and during golf course operations.

Start Date: 1998
Project Duration: Nine years
Total Funding: $218,155

Kansas State University, in cooperation with Jim Colbert, PGA Tour, GCSAA, and various alumni, has built a 27-hole golf course, Colbert Hills Golf Course, near Manhattan, Kansas. The golf course was built on land with a prairie-woodland mix that is typical of the Flint Hills Region. The only previous land use was occasional grazing for beef cattle. The construction and operation of the golf course could possibly impact the surface water quality of nearby streams. Sediment washed away from the construction site would eventually flow into rivers and lakes and cause ecological damage. Excessive concentration of nutrients in rivers, lakes, and reservoirs can accelerate the growth of algae and other aquatic plants, causing problems such as clogged pipelines, fish kill, and restricted recreation.

Four monitoring stations were set up on Little Kitten Creek (the major stream) and its tributaries to collect water samples, measure runoff discharges, and collect precipitation data. Water samples were tested for total nitrogen, total phosphorus, and sediment concentrations. Surface water runoff amounts were studied so that mass transport of nutrients and sediment can be analyzed.

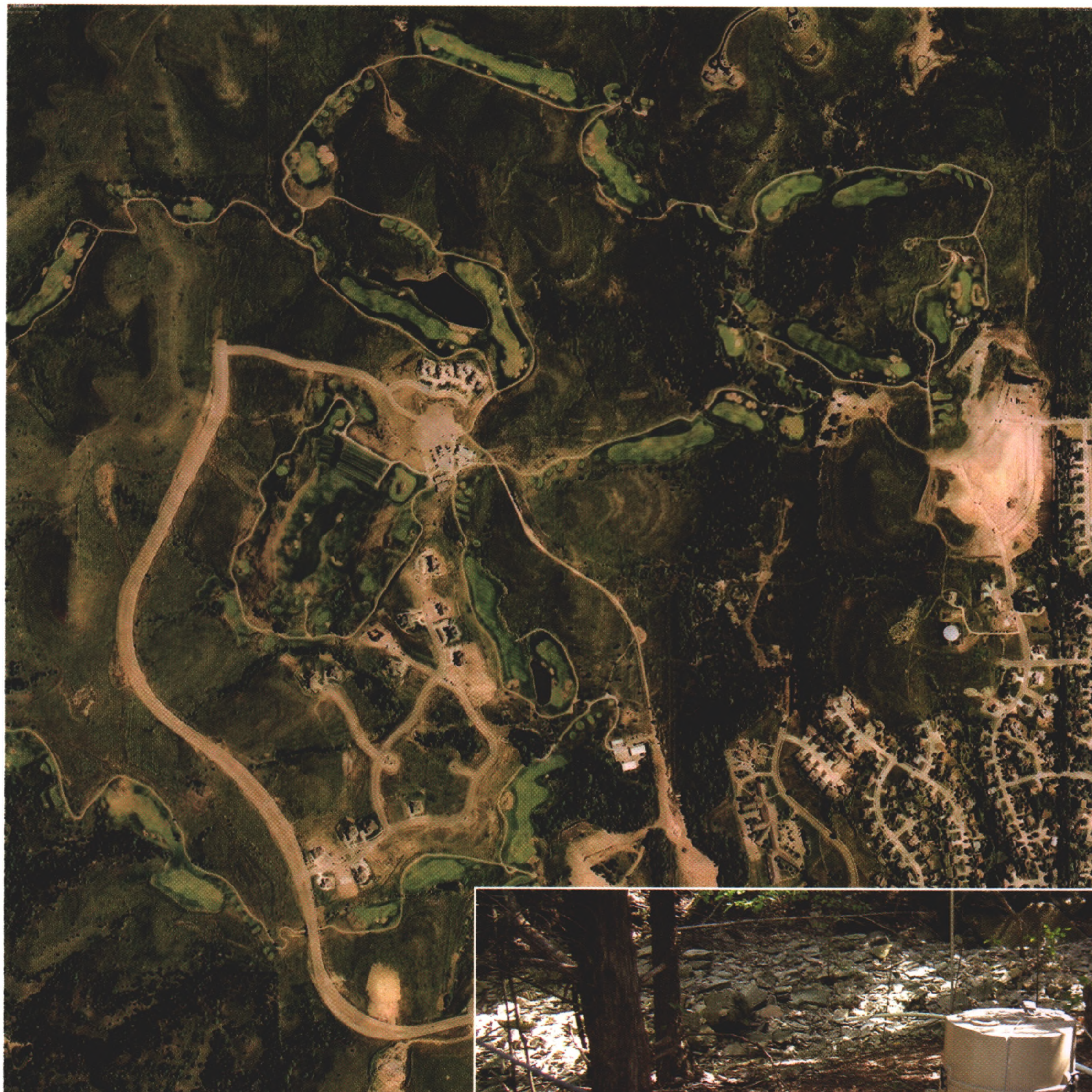
We continued our previous nutrient runoff research by collecting more samples and analyzing data. An average amount of precipitation enabled us to collect more than 120 total samples from inlet and outlet sites this year. We divided the data set into three subsets, namely pre-construction (native conditions), during construction, and during operation. At the main stream leaving the golf course, 28, 138, and 264 surface water samples were collected for the three periods.

Data analysis showed that golf course construction has the greatest impacts on surface water quality, with average concentrations of 3.94 mg/L, 0.93 mg/L, and 2,955 mg/L for total N (TN), total P (TP), and sediment (TSS), respectively, compared with 1.18 mg/L, 0.39 mg/L, and 477 mg/L for the pre-construction period.

During operation, sediment content was brought down significantly to an average of 550 mg/L, slightly higher than that of the native prairie condition. The average concentrations of TN and TP were 2.02 mg/L and 0.49 mg/L, respectively, much lower than those in the construction period, but still over 70 and 25 percent higher than those in the native prairie condition, respectively.

Sources of nutrients in streams under native prairie condition and during construction are thought to be from the input of rainfall and sediment eroded from fertile topsoils. During golf course operation, fertilizer application is another source of nutrients in streams, in addition to those mentioned above. Further analysis shows that there are direct connections between fertilizer application and concentration of TN and TP in streams. There are cases that clearly indicate the amount and timing of fertilizer application are to be blamed. This is the case when a good amount of fertilizer is applied over a large area and significant rainfall comes shortly after the application.

Less sediment in streams during operation is a contribution of golf courses to the environment. Higher concentration of TN and TP than that under native prairie condition is expectable. However, only a few samples have TN greater than 10 mg/L, a drinking water standard. We therefore believe that golf course operation, as a whole, does not pose an immediate threat to the aquatic system.



Aerial photo of the Little Kitten Creek Watershed and Colbert Hills Golf Course area after construction of the golf course near Manhattan, Kansas (terraserver.com).

Four water sample monitoring stations were established around the Colbert Hills Golf Course to collect water samples, measure runoff discharge, and collect precipitation data.

Using preliminary stream flow relationships, we were able to determine the surface water runoff amounts and the mass amounts of nutrient transported offsite. The determined rates of nutrient transport for native conditions were similar to those in the adjacent Konza Prairie Research Area. The rate of nutrient transport during construction was 3 to 4 times that under native conditions, which was consistent with the estimation of sediment yields.

SUMMARY POINTS

- Golf course construction has the greatest impacts on surface water quality, with average concentrations of 3.94 mg/L, 0.93 mg/L, and 2,955 mg/L for total N (TN), total P (TP), and sediment (TSS), respectively, compared with 1.18 mg/L, 0.39 mg/L, and 477 mg/L for the pre-construction period.
- During operation, sediment content was brought down significantly to an average of 550 mg/L, slightly higher than that of the native prairie condition.
- The average concentrations of TN and TP were 2.02 mg/L and 0.49 mg/L, much lower than those in the construction period, but still over 70 and 25 percent higher than those in the native prairie condition, respectively.
- There are cases that clearly indicate the amount and timing of fertilizer application are to be blamed.

CONNECTING THE DOTS

An interview with Dr. Steve Starrett *regarding the Colbert Hills project, monitoring nutrient runoff loss before, during, and after its construction.*

Q: *Was your water quality research at Colbert Hills mandated by the permitting process, or was this project initiated by your own interests?*

A: The research was not mandated by the permitting process. There was a citizens' environmental group that was happy we were performing this research. So that helped smooth out the relationship between the citizens' group and the Colbert Hills leadership.

Q: *Your project was unique in a couple of respects. First, it had a relatively undisturbed area upstream of the golf course development as a comparison for the water quality data. How much seasonal or yearly fluctuation occurs in this pasture or grassland system?*

A: The several hundred acres upstream of the golf course property includes a couple of residential homes, and the rest is lightly used pasture for cattle. This enables us to compare a low-input pasture area to the golf course property. Over the entire project duration, the maximum total nitrogen (N) concentration was 10.4 ppm from the upstream area, compared with 21.5 ppm for the downstream location, which included the golf course. The maximum total phosphorus (P) concentration was 0.45 ppm from the upstream area, compared with 2.98 ppm for the downstream location. Those downstream maximum values occurred during the construction phase. The maximum total N and P concentration during operation at the downstream location was 6.2 ppm and 1.42, respectively. So, the prairie gives up some N in runoff, but P is more tightly bound by the prairie. With respect to seasonal or yearly fluctuations, those differences do not show up because the variability of the data is so much larger in comparison.

Q: *Your data indicate that water quality was most affected during the construction phase of the project. Doesn't the Clean Water Act address the issue of maintaining water quality (i.e., erosion control) during construction? What measures are taken by golf course construction companies to mitigate the effect of golf course construction on the quality of surrounding water resources?*

A: Yes, the largest impact on surface water quality was during the construction phase. The Clean Water Act does cover construction periods. However, the language in the act is very vague, and there are no specific values in the Act that surface water runoff quality should meet because each environmental setting is different. This makes it difficult for contractors and regulators to easily determine that runoff quality is out of compliance. Some key features to use during construction are: permanent sedimentation basins that also serve as detention basins, temporary sedimentation basins, not allowing bare soil to remain uncovered for very long, erosion control blankets, soil binding sprays, mulch, and silt fences.

Q: *What do the results of your study enable you to say to superintendents who are genuinely concerned about environmental stewardship?*

A: Construction areas are critical areas to control runoff. Erosion control is not easy, but there are big benefits to maintaining a reasonable water quality for downstream users. As far as operation goes, continue to use the micro-release fertilizer products, do not spray over water surfaces, cover critical storm drains during application, and be careful about chemical storage. These are the same practices that golf course superintendents have been using for years.

Q: *Are there aspects about your research that you would change if you were to repeat it? Are there cautionary notes that you would share with other researchers who may be considering similar work?*

A: I can't think of any major changes I would make other than to be sure to place water samplers high enough on the bank so that a major storm doesn't wash them downstream. Watershed-scale work is challenging. There are lots of sources of variability: streamflow rates, channel cross sections, year-to-year weather, changes in fertilizer composition, and more. Measuring water quality from an operational golf course is important and valuable to the golf industry. The data can be compared with field-scale plot research projects, and they provide measured water quality information about what is occurring in the watershed.

Q: *What is the "bottom line" message from your work? In your opinion, how do golf courses rank in terms of land uses that may affect the environment?*

A: The bottom line is that the construction phase is critical. There is considerable potential for stream systems to be negatively impacted by high concentrations of soluble solids in the stream. Also, the public notices if the stream water clarity goes from good to bad, so the aesthetic value of the resources is reduced. Several stream biology, avian, plant, soil, and water environmental parameters have been studied at Colbert Hills by myself, Drs. Thein, Robel, Whiles, and others. It is my opinion that once Colbert Hills Golf Course was covered in turfgrass, environmental parameters could return back to prior conditions. Obviously, there is a 110-acre area of managed turfgrass that is going to stay in golf course condition and not be allowed to revert back. Overall, the stream water quality during operation is quite similar to the previous pasture condition.

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

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Breeding Turf for Insect Resistance

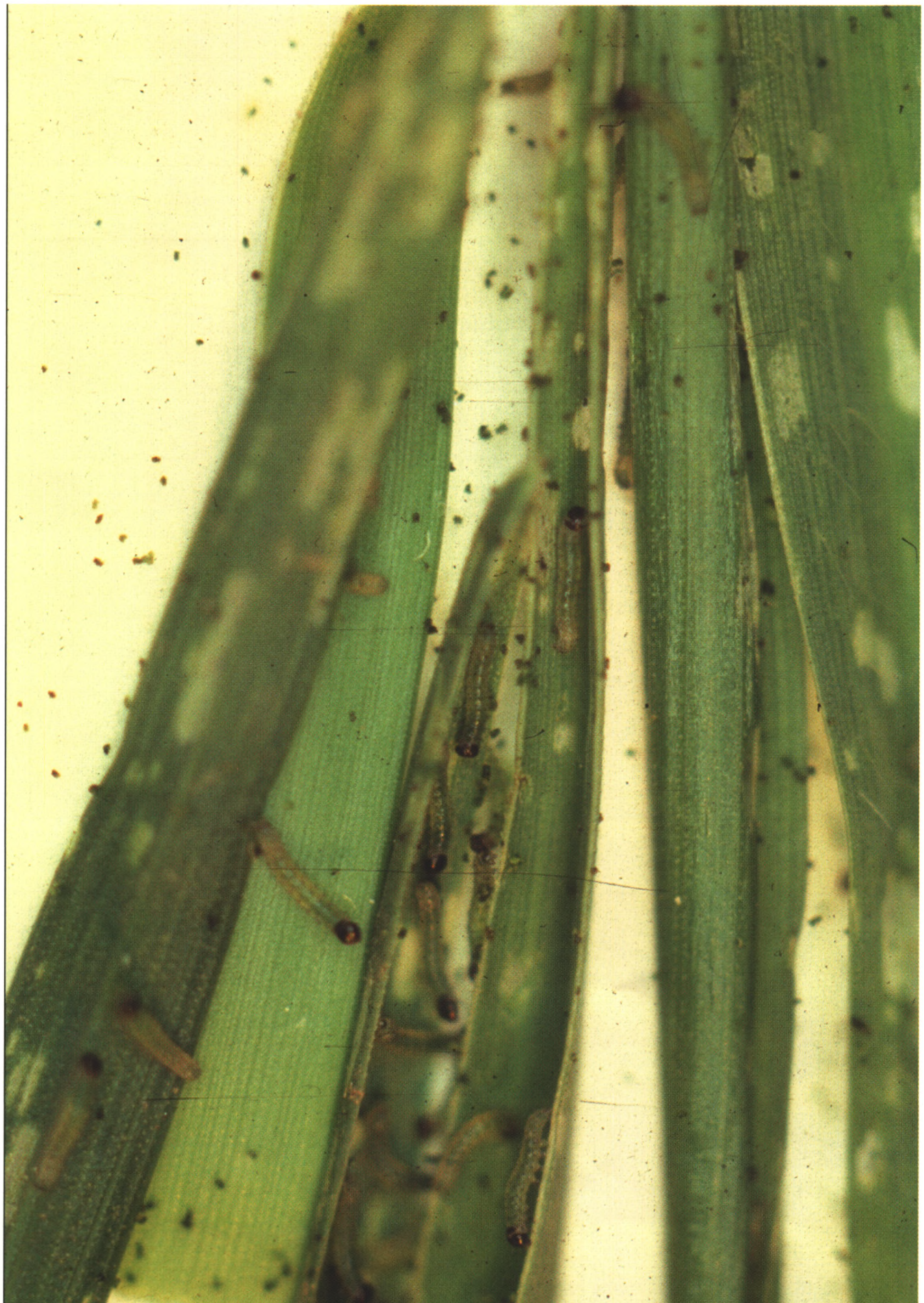
New breeding genetics can reduce pesticide costs.

BY WAYNE HANNA AND KRIS BRAMAN

Insects can be devastating on turf because unless one is watching the turf closely, by the time you realize that you have a problem, many times most of the damage has already been done. Many golf course superintendents have seen armyworms move through turf in a matter of a few hours or days. Another example is chinch bugs — it is almost too late when you see the dead grass.

There are a number of ways to control insects in turf. You can spray an approved insecticide after you see the insects and/or damage. You can spray preventatively, based on environmental and seasonal conditions that favor insect infestation. Or you can plant turfgrasses with built-in genetic resistance. The latter is usually more permanent and is one of the objectives of the turf breeding program in Georgia. In addition, genetic resistance is more economical because it eliminates a large portion of the insecticide costs. Can we completely eliminate insecticide costs on turf? Probably not, but insecticide use and cost could be greatly reduced.

We do not spray insecticides on our turf breeding/research plots at the University of Georgia, Tifton Campus. The reason for not spraying is to allow us to identify plants/hybrids that have genetic mechanisms that discourage and/or reduce insects from feeding on the plants. In our field plots, we do not know if the resistance we see is truly genetic resistance, where an insect will not eat the grass, or if it is non-preference where the insect likes another plant (genotype) better. Therefore, we



Early instar fall armyworm nymphs only partially consume grass leaves, termed window-paning. The early instar stages are easier to kill than larger instar stages that consume entire leaf blades.

Table 1

Mean response of turf bermudagrass hybrids to tawny mole cricket no-choice feeding in the laboratory (34 hybrids) and in the field under "choice" feeding.

	Laboratory Tests			Field Test
Hybrid	Root Dry Weight – % of Control	Number of Eggs after 30 Days	Number of Crickets after 30 Days	Damage Rating 9 = Severe
Tifway	52	5.2	2.8	2.8
TifSport	67	0.0	1.8	3.2
Tifdwarf	44	7.9	3	7.8
Experimental Hybrids (range)	27 to 50	2.4 to 23	1.4 to 3.0	1.0 to 3.8
*LSD – 5%	ns	13	1	0.8

**For differences between means to be significant, the difference must be equal to or larger than the least significant difference (LSD) value.*

Table 2

Growth of fall armyworms on 34 genotypes of bermudagrass in the laboratory under no-choice.

Hybrid	Weight of 10-day-old Larva mg
Tifdwarf	59
TifEagle	60
Tifgreen	34
Tifway	48
TifSport	29
Experimental Hybrids (range)	15 ± 2 to 50 ± 5
*LSD – 5%	14

Note: The smaller the mean, the more resistance to the insect.

**For differences between means to be significant, the difference must be equal to or larger than the least significant difference (LSD) value.*

Table 3

Response of 19 turf bermudagrass hybrids to the bermudagrass mite in laboratory no-choice conditions (means).

Hybrid	Rating A	Rating B
TifEagle	0.3	0.1
Tifway	5.6	4.8
TifSport	4.6	4.9
Tifton 10	2.2	1.2
Experimental Hybrids (range)	0.0 to 5.7	0.0 to 5.0
*LSD – 5%	0.7	0.6

Note: Higher ratings mean more resistance.

**For differences between means to be significant, the difference must be equal to or larger than the least significant difference (LSD) value.*

also conduct laboratory tests, where insects are confined to a specific grass to see if the insects will eat the grass if they are hungry enough.

We have high numbers of natural infestation of tawny mole crickets in our research plots. Therefore, one of the first selection criteria that a new hybrid has to pass is whether the tawny mole cricket likes to eat it. TifSport continues to show good resistance (Table 1). In the Table 1 field experiment, TifSport and Tifway showed similar resistance to the tawny mole cricket. However, in other experiments, TifSport tends to show slightly better resistance under "choice" conditions. The experimental hybrids in the field experiment had already been selected for cricket resistance, and except for susceptible Tifdwarf, most of the experimental hybrids were quite resistant (Figure 1). The encouraging part is that some experimental hybrids appear to be more resistant to the tawny mole cricket than TifSport and Tifway.

TifSport and Tifgreen tend to show good genetic resistance to the fall armyworm under no-choice conditions in the laboratory (Table 2). However, there are advanced experimental hybrids that show even better genetic resistance based on the reduced growth/weight of the larva.

The bermudagrass mite can sometimes be missed unless one is looking for it. Telltale signs are small tufts of leaves at the ends of stems. We evaluated some advanced experimental hybrids and found that some were quite susceptible based on low and zero ratings in Table 3. Most were similar in resistance to TifSport and Tifway.

We observed variation for resistance to the two-lined spittle bug in the centipedegrass introductions and breeding lines that had received little prior breeding or selection for this insect (Table 4). The data indicate that progress can be made for improving two-lined spittle bug resistance in centipedegrass. The genotypes showing the best resistance have been placed in a random mating population for further selection and improvement.

There were no significant differences in the resistance of commercial bermudagrass cultivars to the two-lined spittle bug, except that none of the insects survived on TifSport (Table 4). The test allowed us to identify experimental bermudagrass hybrids that appeared more susceptible and more resistant than the commercial standards.

The goal of the University of Georgia turf breeding program is to develop and identify breeding lines and hybrids that not only show good turf quality but also incorporate insect and other pest resistances, drought resistance, shade resistance, etc. We feel that we are making significant progress in these areas by combining both field and laboratory evaluations of the products from the breeding program. Hopefully, the end products will be superior turf cultivars that will provide reliable performance to the customer.

Fall armyworm damage on a bermudagrass rough can be overwhelming if the entire leaves are consumed during feeding.

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Table 4

Response (means) of bermudagrass hybrids (51) and centipedegrass genotypes (76) to feeding by the two-lined spittle bug in a no-choice trial.

Hybrid or Entry	% Brown Stems on Infested Stems	Number of the Three Original Spittle Bugs Surviving After Day 30
Centipedegrass		
TifBlair	49	1
Experimental Genotypes (range)	13 to 97	0.0 to 2.7
Bermudagrass		
Tifdwarf	64	0.7
Tifway	31	0.7
TifSport	52	0.0
Experimental Hybrids (range)	12 to 97	0.0 to 2.0
*LSD – 5%	41	1.5

For differences between means to be significant, the difference must be equal to or larger than the least significant difference (LSD) value.

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Winter is Not 'Down Time' on the Golf Course

The golf season really begins in the winter, so use that time carefully and effectively.

BY BUD WHITE AND TY McCLELLAN

Golf course amenity repair, refurbishment, or replacement are important tasks that must be accomplished every year for a polished look on the golf course.

S*o what do you do during the winter?* Better question: Who in the golf course management industry has not been asked this question more times than the number of hairs on our head? Okay, perhaps that's an exaggeration, but there are things that make all of us want to pull out our hair, and for turf managers this question qualifies as one of them.

Superintendents who are highly skilled in communication (and patience) look at this as a great opportunity to educate their golfing members, the green committee, neighbors, and even friends and family. Although some superintendents can easily convey a concise, calculated response, others become angered, or at the very least aggravated, in response to this frequent and somewhat irritating question. This begs other questions such as, "Why are there no articles or books available to turf managers concerning winter maintenance?" and "What took us so long to do so?" In searching through the Turfgrass Information File, textbooks, and the World Wide Web, it doesn't take long to realize that there is a lack of resources on the topic of winter maintenance.

Much like sports, the biggest gains in golf course improvements are achieved in the off-season. Necessary and/or desired course improvements oftentimes demand significant time, labor, and occasionally large equipment, all of which result in varying degrees of course disruption. This being the case, the real gains are achieved when additional man-hours are available and work can be performed most efficiently and without causing undue interference to play. During the golfing season, golf course maintenance is geared entirely to daily play and special events, leaving little time to do more than make only minor course adjustments and improvements.

In northern regions of the country where winters eliminate play for several months of the year, or at the very least cause restrictions for play, maintenance staff levels typically increase sometime in April and reach peak levels shortly thereafter. Staff levels then decrease around Thanksgiving, leaving anywhere from five to eight full-time employees on average, including the superintendent and mechanic. Simply put, for real gains to be achieved, golf courses should think twice about how many full-time staff they should keep through these important winter months. Furthermore, sufficient staffing throughout the winter is needed in preparation for best course conditioning when the course opens in the spring.

For northern courses, winter is the time of year in which maintenance budgets are closely inspected, adjusted, and approved. The number of full-time staff needed during the winter months is a typical question that plays heavily on the budgeting process. Ultimately, the appropriate answer to winter staffing levels depends on many variables and is specific to each facility.

The following list of activities and projects won't encompass all that can be performed during the winter months, nor is it supposed to do so. Rather, this article is intended to assist green committees, boards of directors, and other course officials to appreciate and better understand what winter golf course maintenance entails, and to be better educated about determining winter staffing levels for their course. The list of winter duties and projects outlined below might surprise the average golfer.

GENERAL DUTIES

Snow Removal from Roads and Parking Lots: Most, if not all, northern golf courses have at least some snow removal responsibilities during the winter. Depending on acreage and annual snowfall, snow removal requirements for some courses will be much more extensive than for others. Given the unpredictability of winter weather events, it is generally required that at least one person be kept on call for clearing snow during such events. Snow maintenance includes plowing roads and parking lots, blowing or shoveling walkways, and applying de-icing agents.

Winter Play Setup Duties: While generally not recommended in the northern United States, some winter play does occur and golfers still have expectations for course conditioning. It should also be noted that if winter play is allowed, not only should more staff be in place during the winter to accommodate play, but many more labor hours will be required to repair the course for the beginning of spring play (another article in itself).

Landscape Cleanup: Snow, ice, wind, and rain require debris cleanup across the property, whether it be to accommodate winter play or to prepare the course for spring opening. This includes downed tree branches and accumulations of leaves, soil, or anything that moving surface water leaves behind on the grounds. Remulching landscape and flower beds is another great winter project.

Covering Greens: For courses that annually suffer winter damage to their greens, covering them with straw, tarps, or synthetic covers, and heavy sand topdressings, just to name a few, can be essential to avoid turf loss. Many man-hours are required in covering and protecting greens, particularly if covers must be removed or applied several times throughout the winter.

Monitoring Ice on Greens: If by mid-February or early March continuous ice cover still exists, it may need to be removed or broken to allow gas exchange to avoid turf loss due to lack of oxygen. Although winter injury is poorly understood despite decades of research, the threshold for *Poa annua* is assumed to be close to about 50 days, whereas creeping bentgrass can tolerate continuous ice cover much longer. Regardless of these guidelines, monitoring of ice is necessary in northern states and, depending on the intensity and duration of the winter, breaking ice to save greens may be required.

Snow Removal from Greens: Snow is welcome during the winter, insulating the turf from desiccating winter winds and temperature extremes, but sometimes it must be removed from greens to hasten ice melt, speed surface thawing during the spring, or allow surface melt to be directed off the greens where it cannot accumulate and refreeze. Snow removal from greens is almost always performed manually so as to avoid mechanical damage to green contours.

Monitoring Course Conditions: In addition to monitoring the golf course regularly, many superintendents frequently perform plug checks to monitor turf health and check for winter damage. This is done by removing soil samples and placing them indoors on window sills where they warm with sunlight. Doing so in advance is a great way to determine if winter turf injury will be an issue, in which case communication and recovery plans can begin.

Painting greens is an increasingly popular project on dormant, non-overseeded ultradwarf bermudagrass greens.

Winter Fungicide Applications: In northern climates, various numbers of timely fungicide applications are used for control of pink snow mold, or Microdochium patch (*Microdochium nivale*), and gray snow mold (*Typhula* spp.) that frequent most cool-season turfgrasses.

Winter Weed Control: For facilities in the transition zone, where bermudagrass and zoysiagrass go completely dormant, controlling actively growing winter weeds, such as *Poa annua*, with pre- and post-emergent herbicides is a must. As with all pesticide applications, staff are required to be trained and certified.

Burning Native Roughs: Burning in early spring is the best weed control method and the healthiest management for maintenance and cleanup of native vegetation. It has always been Mother Nature's way of maintaining the native plains. In addition to a burn permit, make sure to notify applicable parties in the area when burning, including the fire department.

Advance Ordering of Fertilizers, Pesticides, and Other Chemicals: Bulk ordering of fertilizers and pesticides during the winter months can produce significant cost savings as a result of early order discounts, but doing so requires excellent forecasting, budgeting, and planning, all of which takes time. Although this certainly applies to all facilities, those owned by management companies, government agencies, municipalities, and the like require a minimum of three bids for each specification of a product purchase. Depending on the situation, creating detailed specifications to obtain fair, competitive bids for every purchase order can be quite demanding of your time.

Capital Purchases: Maintenance equipment and other capital purchases typically require similar purchasing and bidding processes, as outlined above for chemicals and fertilizers.

Continuing Education: Whether it be the annual Golf Industry Show, local superintendent chapter meetings, USGA regional conferences, pesticide recertification workshops, etc., continuing education is needed to stay abreast of the newest chemistries, technologies, products, and techniques. Continuing education is required not just in certain instances (such as pesticide applicators); it is integral to the success of the facility.

TYPICAL WINTER PROJECTS

Annual Equipment Maintenance and Repairs: Some equipment operates seven days a week all through the growing season, and others run two to three days per week on average. Parts become worn and need to be replaced, fittings loosen, bearings and seals wear out, engines and motors require tune-ups, and wiring needs to be inspected.

Extensive preventative maintenance in the winter is crucial for equipment reliability during the golfing season, and reducing costly breakdowns results in substantial cost savings. Additionally, there simply is not time to have multiple pieces of equipment waiting for parts or repair during the summer. While breakdowns in the summer cannot be eliminated, winter prevention and maintenance can go a long way in assisting with equipment durability and dependability.

Keeping equipment clean and operating efficiently does not just mean a better conditioned golf course; it also increases equipment longevity and trade-in value. "The value of the maintenance fleet more than justifies preventative maintenance and regular service. Maximizing the investment in equipment is good business sense and important to the viability of the overall golf course operation."[1] Do not forget equipment painting needs as well.

Mower Blade Sharpening and Reel Grinding: With dozens of reels and blades on multiple fairway, green, tee, and rough mowers, diligent sharpening and grinding of cutting units in-house takes weeks. Some courses contract out this work, but it can be very expensive. As such, investing in reel and blade grinding/sharpening

Snow cover completely shuts down any maintenance operations . . . or so many think.

equipment, and performing this job in-house, can produce significant cost savings. Bearings, seals, and roller rebuilding are necessary, too.

Tree Maintenance: Selective tree removal and pruning is needed annually to improve growing conditions by increasing sunlight exposure and air flow. Trees or branches that unduly interfere with play or intended architectural design should be eliminated. Annual winter tree maintenance also includes thinning of dense tree populations to reduce overcrowding, clearing understory brush, raising canopies for improved air flow, and addressing trees damaged during winter storms.

Drainage: Limited or no play during the winter is a great time to address deficiencies in drainage. This includes repairing existing drainage tile that has become compromised and no longer functions properly, or the addition of new drainage in areas that drain poorly. To improve poorly draining areas or small pockets that hold water, this can also be achieved through regrading drain basin contours.

Irrigation System: All facets of an irrigation system require annual attention. This includes routine servicing of pump stations as well as upgrading deteriorating irrigation components, leveling heads, and mapping of new irrigation lines and heads.

Putting Green Collar Maintenance and Leveling: Collars are areas of the course that are often overlooked, but they benefit from routine maintenance. This includes leveling, redefining widths, expansion, and relocation.

Tee Leveling, Rebuilding, and Expansion: Intense play and divoting from the centers of teeing grounds may produce surface unevenness that causes playing areas to remain wet, as surface water no longer exits off the tees as originally designed. The opposite also can be true. If aggressive divot-filling programs are in place, excess accumulation causes the center of tees to form a crown. Or, throughout the season it may be obvious that a tee is simply undersized for the amount of play it receives, which is most likely on holes 1 and 10, where additional practice swings are frequently used. In either case, the winter months provide a great opportunity to level, rebuild, or expand tees for the upcoming season.

Bunkers: The general industry standard for the lifespan of bunker sand is five to seven years before it must be replaced. This occurs because silt and clay impede bunker drainage and offer poor playability. Winter months are a great time to replace bunker sand, if needed, or replenish sand if more is needed. To keep bunkers draining properly, it also is wise to inspect the drain system so that tile lines can be cleaned or replaced.

Cart Path Repair: At some point, highways and streets require repair, and cart paths are no different. Winter months, when temperature and conditions allow, are a great time to prepare cart paths for the upcoming season. Curbing can be built as well.

Maintenance Facility Improvements: An organized, clean, and operative maintenance facility does not happen by itself, and directing some attention here goes a long way to improving employee morale, better productivity and efficiency, and attracting and retaining quality employees.

Pump House, Rest Stations, and Other Small Buildings: There is no rule that states that these structures must be eyesores. Rather, when routinely painted and well maintained, even these facilities can be aesthetically pleasing.

Golf Course Accessories: These include tee markers, wastebaskets, ball washers, benches, bunker rakes, bag racks, etc., and because all are outdoor accessories that endure the elements, all require restoration every now and again. Golf course accessories should be cleaned, repaired, refurbished, painted, or built new, when necessary. New or updated accessories are noticed by golfers.

Soil Testing: Although it may not be practical to obtain soil samples during the winter, it is an opportune time to review soil test results from the previous season (and past years to evaluate trends, if any). Fertility needs should be addressed, and changes, if any, can be anticipated for the upcoming season. This allows for late winter soil amendment applications that may be in order.

Water Testing: Winter is a good time to establish baseline numbers on water purity, as water should be at its purest at that time. By running a water test in the winter and again in midsummer, the relative ranges of water quality used to irrigate your golf course can be obtained.

Miscellaneous: Other projects that can be performed during the winter may include installing a brick patio outside the clubhouse, installing a deep well, repairing a leaking water fountain line, cleaning/servicing/painting/installing large fans used to circulate air on greens, refurbishing the facility's main entrance gate, and everything in between. Winter also presents a great time to develop maintenance standards and review safety and training procedures.

There's lots that can be achieved during the winter months, and a winter crew can do so much for your course over time. Continuity of staff throughout the year is extremely important in regard to developing an experienced, responsible, and efficient crew. Similarly, staff continuity throughout the winter reduces time spent training new employees from one year to the next and minimizing rookie mistakes that can be very costly.

The exact number of employees to staff through the winter depends upon specific requirements of the facility. Keep in mind that course conditioning and preparation for the golfing season really begins in the winter, so think again and carefully weigh all the options before considering crew layoffs during the winter. Come time for the member-guest, club championship, or any other significant event at your course, you'll be glad you did.

Drainage construction is a perfect winter project when play and other seasonal maintenance jobs are minimized.

REFERENCE

[1]Nelson, M. 2004. Mountain standard time (February, 2004). USGA World Wide Web Site.

BUD WHITE *is director and* TY MCCLELLAN *is an agronomist in the USGA Green Section's Mid-Continent Region.*

Reducing Pesticide and Nutrient Runoff from Fairways Using Management Practices

Scientists at the University of Minnesota investigate how superintendents play a key role.

BY PAMELA RICE AND BRIAN HORGAN

OBJECTIVES

- To quantify pesticide transport with rainfall runoff and evaluate the ability of management practices to mitigate pesticide and nutrient loss with runoff.
- To evaluate the mobility of snow mold fungicides and late-fall fertilizer with rainfall and snow-melt runoff.
- To determine the impact of location of chemical application to their transport with surface runoff.

Start Date: 2005
Project Duration: Three years
Total Funding: $90,000

We designed experiments to measure the quantity of fertilizers and pesticides transported with runoff from golf course fairway turf, and to evaluate the ability of management practices to reduce the transport of applied chemicals with runoff. During the 2005 season, half of the plots were aerified with solid tines, while the remaining plots were aerified using hollow tines. Cores removed with the hollow tines were allowed to dry, broken into smaller pieces, and worked back into the turf.

Fertilizer (18-3-18; N, P_2O_5, K_2O), a conservative tracer (potassium bromide), and a commonly utilized herbicide (2, 4-D), insecticide (chlorpyrifos), and fungicide (flutolanil) were applied to all plots 12-36 hours prior to the initiation of the simulated precipitation. Rainfall simulations and collection of resulting runoff were completed 2 days and 63 days following aeration (2d, 63d).

Runoff volume was reduced in fairway turf plots aerated with hollow tines relative to solid tines. When plots were aerated 2 days prior to initiation of the rainfall simulations, the plots aerated with hollow tines demonstrated a 55% reduction in total runoff volume compared to plots aerated with solid tines. Similar trends were observed when plots were aerated 63 days prior to simulated rainfall and runoff. However, the difference in measured runoff volume was reduced to 10%.

Chemical analysis of the runoff water revealed a greater than 30% reduction in quantities of phosphorus (soluble-P), ammonium nitrogen (NH_4-N), and nitrate nitrogen (NO_3-N) measured in the runoff from turf plots aerated with hollow tines 2 days prior to initiation of the rainfall simulations compared to plots aerated

Nutrient and pesticide runoff from fairways can be mitigated using hollow-tine aeration when compared to management with solid-tine aeration.

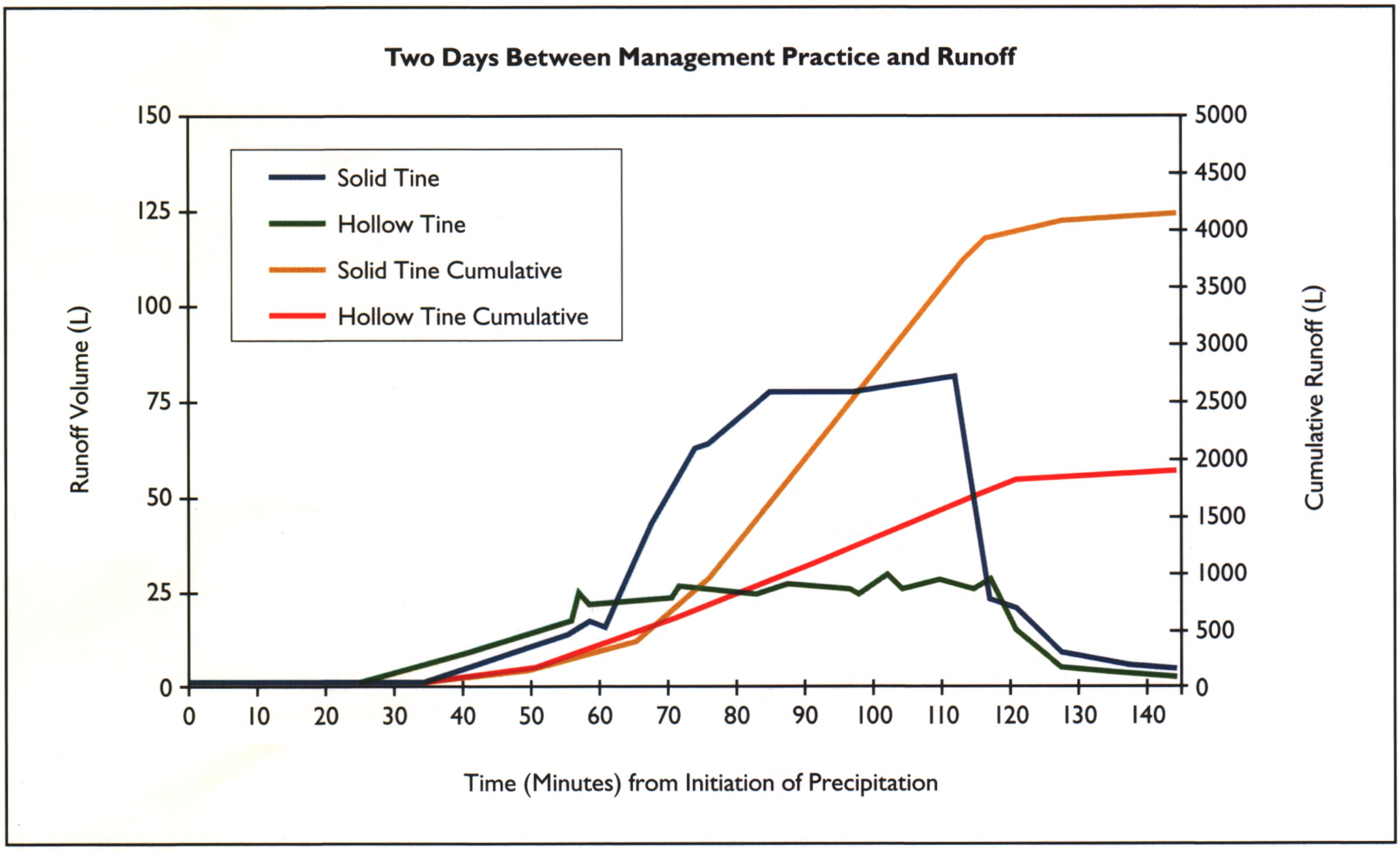
Rain simulators were used to produce runoff 2 and 63 days after aeration treatments. Runoff was then analyzed for 2,4-D, chloropyrifos, flutolanil, and a potassium bromide tracer.

with solid tines. A 5% to 27% reduction in nutrient loss with runoff from the hollow-tine plots remained even when the time between aeration and runoff increased to 63 days. Results of the pesticide analysis show a 15% to 56% reduction in quantity of pesticides measured in runoff from plots aerated with hollow tines compared to solid tines.

An additional management practice, vertical mowing, was evaluated during the 2006 season. Prior to the first rainfall simulation and collection of runoff, all plots were treated identically with weekly sand topdressing and aerified with hollow tines 11 days before the chemical application. Cores removed with the hollow tines were allowed to dry, broken into smaller pieces, and worked back into the turf. Volumes of runoff collected from the plots were similar.

Five weeks following the first rainfall simulation, all plots were aerified a

Research at the University of Minnesota determined that solid-tine coring was less effective than hollow-tine coring in reducing runoff losses from fairway turf.



Preliminary results of fertilizer transport show reduced runoff volume, nitrogen loss, and phosphorus loss with hollow-tine aeration compared to solid-tine aeration.

CONNECTING THE DOTS

An interview with DR. BRIAN HORGAN *regarding the runoff mitigation work at the University of Minnesota.*

Q: *The preliminary results of your study are very promising and seem to offer superintendents a real tool to help mitigate fairway runoff losses. Please explain how the potassium bromide tracer is used in this study.*

A: As a salt, potassium bromide, KBr, is water soluble. When the salt dissociates, the bromide acts similarly to nitrate, NO_3^-, and water-soluble pesticides like 2,4-D. The use of KBr in these studies allows us to validate results for water-soluble nutrients and pesticides we identify in runoff.

Q: *How widely is solid-tine coring done in Minnesota, and do you think your data will influence superintendents to choose hollow-tine coring as a stronger management plan to mitigate runoff?*

A: On fairways, both hollow- and solid-tine coring are common practices, depending on the overall objective of the aerification practice. For those superintendents not managing a thatch problem, convincing them to use a more labor-intensive hollow-tine coring technique to reduce pesticide movement may be a challenge.

Q: *Please describe the timing and application rates of late-fall fertilization. Is late-fall fertilization commonly practiced on Minnesota golf courses? Do you have sufficient data to determine how different fairway aeration methods affect nutrient runoff? If so, how much difference did the treatments make?*

A: The "art" of late-fall fertilization is not a perfected science. Golf courses that apply a late-fall fertilizer wait until just after a mowed turfgrass no longer produces clippings. At this time, roots are still actively growing and producing and storing sugars for winter survival and spring green-up. Data are still being analyzed to determine the impact of fairway aeration methods on nutrient runoff from late-fall applied fertilizers.

Q: *What is the public's perception of the effect of Minnesota golf courses on water quality? What state and/or local regulatory restrictions are in place regarding nutrient and pesticide applications to Minnesota golf courses?*

A: Minnesota is the first state in the country to restrict the use of fertilizers containing phosphorus applied to turfgrass. Throughout the debate, the positive attributes associated with proper applications of fertilizer applied by educated turfgrass managers were defended. Golf courses received an exemption to the law following training. Over 500 golf course personnel have received this ongoing training.

Q: *Do you feel you have enough definitive results from this study to include hollow-tine coring and vertical mowing in a best management plan (BMP) to mitigate pesticide and nutrient runoff from Minnesota fairways?*

A: Yes, a greater than 27% reduction in nutrient runoff and up to 56% reduction in pesticide runoff is possible when using hollow-tine coring and vertical mowing as a BMP.

Q: *How are golf course superintendents reacting to this information when it is presented at conferences and field days?*

A: Very positively. Golf course superintendents are looking for ways to enhance their environmental stewardship. This research provides tangible options and opportunities.

Q: *Have you gotten reaction to this work from scientists in other states that may be interested in extrapolating your work into their own BMPs?*

A: Data have been presented at scientific conferences around the world and the reaction by our peers has been positive. Three manuscripts have been submitted to various journals for peer review.

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

second time. Seven days later, half of the plots received vertical mowing to increase water infiltration and further manage thatch. The fertilizer, pesticides, and conservative tracer were applied 8 days following the vertical mowing and within 24 hours of the second rainfall simulation. Chemical application, rainfall simulation, and sample collection followed the protocol initiated in 2005.

Infiltration measurements, quantification of runoff volumes, and examination of hydrographs revealed the addition of vertical mowing increased water infiltration and further reduced quantities of water leaving the turf plots as runoff. Measured nutrient and pesticide loads transported with the runoff showed the addition of vertical mowing reduced soluble-P and nitrate nitrogen (NO_3-N) losses by 27% and 39% and fungicide (flutolanil) and insecticide (chlorpyrifos) losses by 11% to 29%.

Additional cultural practices were implemented, followed by chemical application, rainfall simulation, and sample collection. Results of this research will provide information that will allow for informed decisions on best management practices that are both environmentally responsible and provide quality turf.

SUMMARY POINTS

- Aeration of fairway turf with hollow tines reduced runoff volumes, nutrient loss with runoff, and pesticide loss with runoff compared to management with solid-tine aeration.
- Addition of vertical mowing to hollow-tine aeration increased water infiltration and further reduced quantities of water leaving the turf plots as runoff.
- Addition of vertical mowing to hollow-tine aeration reduced the off-site transport of nutrients (soluble-P, NO_3-N) and pesticides (flutolanil, chlorpyrifos) with runoff.

RELATED INFORMATION

http://turf.lib.msu.edu/ressum/2007/53.pdf
http://turf.lib.msu.edu/ressum/2006/49.pdf
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Are Ultradwarf Bermudagrass Cultivars Mutating?

Do the industry rumors that ultradwarf cultivars mutate mean that your putting greens will deteriorate?

BY J. EARL ELSNER

In the late 1990s, ultradwarf bermudagrass cultivars challenged the dominance of Tifdwarf on warm-season golf courses. In 2008, they are the cultivars of choice on a majority of southern golf courses. Their green speed, smoothness, and firmness delight golfers. The apparent absence of mutations encourages superintendents. Ultradwarf cultivars are planted on more than 14,000 greens, and it does not appear that the putting greens are developing off-type patches or deteriorating surface quality like Tifdwarf. There are examples of collar encroachment by Tifway and other cultivars. There are a few situations where plants from previous putting greens have survived and very few situations where contaminants were introduced from production fields or nurseries. Ten years and 14,000 greens with very few contamination issues is a remarkable accomplishment.

Mutations disrupt surface putting quality due to the ensuing contamination.

A stoloniferous or above-ground stem mutation is observed at an ultradwarf production field. These mutations can occur in various morphological forms, but certification agencies and producers work hard to ensure these rarely appear on putting greens.

However, it has not been uncommon to find apparent mutant off-type plants in ultradwarf production fields. Usually, but not always, these are individual patches that are tennis ball to basketball size. The morphology varies and is similar to typical off-type plants in Tifgreen and Tifdwarf putting greens and production fields. So the question becomes — why do ultradwarf mutations survive in production fields, but not in putting greens?

This article considers several questions about mutations in bermudagrass putting green cultivars. Hopefully, it will relieve superintendent concerns that ultradwarf green surfaces will deteriorate like Tifgreen and Tifdwarf. An important point is to encourage continued diligence by growers and certification agencies.

All DNA-based organisms have mutations, some more than others. Germ line nuclear DNA mutations are an important source of heritable characteristics used to develop superior cultivars. Mitochondrial DNA mutations are the basis of Darwinian evolutionary models, which suggest that modern humans have a common female African ancestor and support theories about human migration routes out of Africa. Somatic DNA mutations are the source of nectarines, navel oranges, novel ornamental plants, as well as Tifdwarf (Burton, 1965) and the ultradwarfs.

Discussions about mutations in putting greens cause fear and dread, but with the absence of somatic mutations, Tifdwarf and the ultradwarfs would not exist. None of the many thousand *C. dactylon* x *C. transvaalensis* seedlings in Drs. Glen Burton (1971), Wayne Hanna, and Charles Taliaferro's programs has equaled Tifdwarf or the ultradwarfs' close mowing tolerance. Therefore, mutation breeding and selection of naturally occurring mutants in the Tifgreen complex has been necessary for the development of cultivars capable of providing fast green speeds and surface quality required by golfers.

In the grand scheme of vegetative turfgrass propagation, the number of naturally occurring somatic mutation events resulting in different plant morphology is variable, but quite small. Caetano-anollés described the Tifgreen genome as unstable and calculated somatic mutation events in the Tifgreen complex to be less than 1 per 10^8 nucleotide generations (Caetano-anollès, 2002). On the other hand, the Tifway genome was described as being stable. Caetano-anollès' data confirm the extensive experience with Foundation and other Tifway nurseries where mutation occurrences have never been documented. Thus far, all off-types that have been investigated in Tifway plantings have been contaminants introduced from outside sources.

One mutation event in 10^8 nucleotide generations seems to be an almost negligible number. However, if the assumption is made that each bermudagrass stolon node (a node has the potential of at least two lateral buds and each lateral bud equals one nucleotide generation) represents one nucleotide generation, then considering the number of nodes in a production field or putting green, it should not be surprising that mutations may be an issue in Tifgreen and its derivative ecotypes. This simple correlation also emphasizes that freqently harvested sprig fields have a higher risk of mutations as compared to the relatively stable putting green environment. In a production field, massive numbers of vegetative buds are produced after each harvest. Each time a new vegetative bud forms, chromosomes are at risk to have changed, which can give rise to a new plant with different morphology and growth characteristics. Fortunately, a majority of mutations are not competitive and do not persist in the population, but those that do persist can cause considerable havoc.

This author has seen examples of many of the morphological types described by Burton and Powell (1971) in turf farms and putting greens around the globe. They vary from growth rates like Tifgreen to more dwarf than the ultradwarfs, leaf color from canary yellow to intense dark green, prolific seedhead production to almost an absence of seedheads, long narrow to short broad leaf blades, along with different responses to herbicides, high temperatures, and cool nights. It appears that an almost infinite number of morphological types can occur in the Tifgreen complex.

There is a great deal of evidence that the mutation potential of the Tifgreen complex is maintained in other members of the family, whether it is Tifdwarf, an ultradwarf, or other selections. Also, research in several laboratories utilizing various DNA fingerprint techniques has consistently shown that each of the current ultradwarf cultivars is closely related to Tifgreen and Tifdwarf and distantly related to the more genetically stable Tifway (Goatley et al., 2005; Williams, 2003). Therefore, it should not be unexpected that mutations occur in ultradwarf production fields. Field inspections support these conclusions.

Theoretically, the survival of a mutant depends on its selective advantage or disadvantage relative to the management of the matrix population where it occurs. Experience has shown the following relationships:

- When an ultradwarf type plant develops from a mutation event in a Tifdwarf putting green, the more dwarf plant should have a selective advantage for mowing height. If other physiological characteristics are at least equal, the mutant produces an expanding, dense, thatchy, and grainy circular patch. It also may contaminate other putting green areas via mechanical operations (vertical mowing, aeration, and cup placement).
- If contaminant sprigs with growth characteristics similar to Tifgreen or Tifdwarf are planted in a newly sprigged ultradwarf putting green, the contaminant will grow very rapidly and out-compete the ultradwarf. When mowing height is lowered, the competitive relationship shifts in favor of the ultradwarf. Ultimately, the non-ultradwarf plants will be suppressed by mowing and may disappear entirely, but in the interim, putting surface quality may be compromised.

The preponderance of evidence supports the premise that successful mutations occur in ultradwarf production fields, but mutants have not been an issue when the event occurs in ultradwarf putting greens. The reason for the ultradwarf mutants' apparent lack of competitiveness in putting greens is not known. It may be that they have physiological or other disadvantages, preventing the establishment of a distinct population in the putting green. It may be that the mutants' colors and leaf morphology under greens management is similar to the ultradwarf cultivar such that they blend in and do not disrupt the uniform putting green surface. Or, it may be a combination of these factors and others, depending on the characteristics of specific mutations.

Ultradwarf mutations in sprig fields, however, are and should be a cause for concern.

- If a mutant plant with growth characteristics similar to Tifgreen or Tifdwarf becomes established in an ultradwarf production field, each time the sprig field is harvested, the more aggressive plant will expand faster than the ultradwarf. After multiple harvests by traditional sprig digging equipment, the aggressive plant will likely become the dominant type.
- If a mutant plant with growth characteristics similar to or more dwarf than an ultradwarf occurs in a sprig field, the mutant may persist, but should not expand. However, if this mutant has significantly different leaf color and contaminates harvested sprigs, it may be noticeable in the new ultradwarf green.

Meticulous roguing is required to maintain genetic and morphological uniformity in ultradwarf production fields. One of the keys to the low frequency of contamination in ultradwarf putting greens is the attention that producers and certification agencies have placed on morphological uniformity as compared to the emphasis during most of Tifdwarf's tenure. It is important for turf growers and certification agencies to be even more attentive as the ultradwarf cultivars become older. The mutation potential should not change, but each new successful mutant adds to the potential cumulative off-type load that may be present in a production field. Each must be identified and removed, or else there may be a disaster waiting to happen.

The final question: When is a variant plant considered to be an off-type? Observant superintendents many times see plant variation in their bermudagrass putting greens and want a DNA fingerprint. The rule of thumb in the Georgia Certification program, almost a paradigm, is that DNA fingerprints are tools but not necessarily the final answer. *If a plant looks different, grows differently, or reacts differently, it is an off-type.* In certain situations the microenvironment will cause confusion such that a normal plant may take on characteristics of an off-type. Under these conditions, a uniform pot grow-out is used to confirm whether it is an off-type by comparison to a known standard of the cultivar.

A recent situation with seashore paspalum illustrates the reason that morphology and growth characteristics may be more effective than DNA fingerprints for labeling a plant an off-type. A putting green had off-color patches of suspect off-types. Three samples were obtained from areas with different color or growth characteristics. The DNA fingerprints indicated that one was different from the matrix cultivar, one was slightly different, and one was indistinguishable. However, all three plants met the off-type definition because they had different morphological and/or growth characteristics. The opposite also occurs when a DNA fingerprint may falsely label a plant as an off-type because the fingerprint utilized polymorphorisms that do not influence plant growth characteristics.

In conclusion, ultradwarf putting greens have a good track record of providing excellent putting surfaces with no indication of deterioration due to putting green mutations. Ultradwarf sod and sprig producers have been diligent in maintaining genetic, morphological, and physiological uniformity. Diligence will have to be increased if the next ten years are to be as successful as the first ten years of ultradwarf sprig and sod production.

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Tifway bermudagrass encroachment into an ultradwarf putting green surface occasionally happens, but it is very rare. Ultradwarfs usually have a significant advantage over bordering turfgrasses at low mowing heights on putting greens.

Getting Through the Winter

Helping frogs and salamanders survive.

BY JOSHUA CONWAY

You can do many things to encourage frogs on your golf course and in your local community. The simple actions you take, when repeated many times over by landowners, can have a significant positive impact. And an abundance of frogs on your property will be strong evidence that you are taking good care of both land and water.

Frogs are amphibians, a word of Greek origin that means *two lives.* Most adult frogs live in damp places in woods or near streams or ponds. But when mating season comes, usually in the spring, they migrate to ponds, wetlands, and seasonal pools to lay their eggs. The eggs hatch into tadpoles, a completely aquatic stage that breathes with gills and eats algae. Depending on the species, they remain in the tadpole stage for as long as a year before they develop legs and lungs and move onto land as adults.

Eggs, tadpoles, and adult frogs are a crucial component of many ecological communities. A vital link in the food chain, they serve as food for aquatic insects, fish, mammals, and birds. But carnivorous adult frogs do their share of eating, too, feeding on mosquitoes, flies, and aquatic invertebrates. Some frogs even eat small fish, amphibians, reptiles, birds, and rodents. A recent study found that a healthy frog population removes more than 50,000 insects per acre per year during the spring and summer months. Winter, on the other hand, is a critical time for all wildlife species, including frogs. Severe weather in many regions, combined with diminished food supplies, presents a formidable challenge, and many don't survive.

Southern chorus frog. Photo by Marvin Bouknight, Oldfield Naturalist, S.C.

Instinct prepares wildlife to meet the hardships of winter in a variety of ways. Migratory birds have long since flown to wintering grounds in the southern U.S., Mexico, and Central and South America. Mammals have completed intense eating periods or hoarded this year's natural harvest in order to store fat for the lean months ahead. Amphibians, too, are getting ready for winter, and there is much you can do to lend a helping hand.

Regional differences in the severity of the season ahead have a profound influence on how frogs and salamanders spend the winter. In the southern U.S., many frogs and salamanders are active throughout winter months. Winter rains in Florida, for example, can bring on a great deal of active migration, calling, and reproduction. In contrast, freezing weather in the northern parts of the U.S. and Canada stops all amphibian activity and forces a period of hibernation.

PROVIDING HIBERNATION SITES

Because amphibians regulate their internal body temperatures with external heat sources, like the sun, they are known as ectotherms. When temperatures drop, amphibians restrict their activity and diet, allowing them to survive extreme temperatures. Some, like the wood frog, which breeds inside the Arctic Circle, can even freeze to some extent without dying. However, all amphibians in cold areas need a place where they can be protected from the worst extremes of winter.

- **Ponds:** Hibernation sites differ among various groups of amphibians. Many aquatic amphibians hibernate in mud and debris at the bottom of a pond. Some spring breeders, like leopard frogs, also have been reported to hibernate in the sites they will use for breeding activity in the spring. In addition, some species have larval stages that require more than one growth season to metamorphose into adults. For all of these amphibians, it is important that water levels be sufficiently deep so the pond bottom doesn't freeze solid in midwinter. Refrain from draining ponds, as this practice can cause aquatic amphibians to perish.

- **Wooded Areas:** Other aquatic breeders, like wood frogs and mole salamanders, hibernate in their summer habitat locations, generally in wooded areas, and wait until spring to move to breeding ponds. These species typically hibernate under leaves, logs, rocks, and other cover objects. For them, as well as for the terrestrial breeders like many of the lungless salamanders, it is important to have sufficient cover on the forest floor. Leave rocks, limbs, debris, leaves, and other cover materials in woodlands. Amphibians will burrow under cover for warmth and protection.
- **Streams:** Population studies suggest that certain species also migrate to streams to spend the winter in moving water that contains more oxygen than still water. It is not certain how common this wintering behavior might be, but it is likely to occur in places that get cold enough to freeze the surface of ponds, but not the running water in streams. Remove limbs and other debris from streams to ensure continuous water flow as the surface waters freeze.
- **Travel Corridors:** Regardless of whether frogs and salamanders move in the spring or fall, and regardless of whether they spend the winter in their breeding habitat, their summer habitat, or a third location, they all need to move back and forth between these different places. Make sure your property includes a network of suitable habitat connections that link breeding, summer, and winter habitats together. Movement distances can be 500 feet or more between these habitats.

LEAPERS, CLIMBERS, WALKERS, AND SWIMMERS

There are close to 100 different species of frogs in North America, so what species you have on your property will depend on where you are. In general, there are several main groups that you are likely to see in most places. The accompanying chart describes the most common types of frogs.

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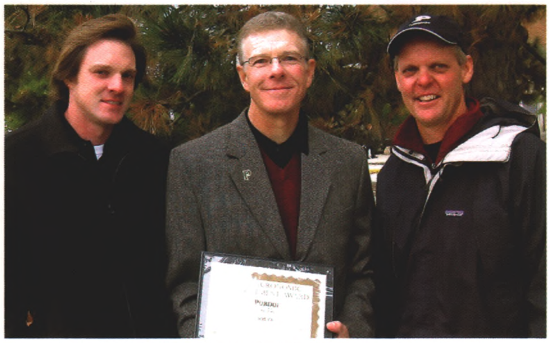
The Most Common Types of Frogs

Type	Description	Examples
Water Frogs or True Frogs	Tend to be large and green, with long legs for leaping; true frogs are found near water. Some, like the bullfrog, stay in ponds all summer, while others prefer to retreat to land after breeding takes place.	Bullfrog, Green Frog, Wood Frog, and Leopard Frog
Toads	Tend to be brown, dry, and warty, with short legs for hopping. They can be found hopping around in broad daylight (unlike most frogs, which are nocturnal).	Woodhouse's Toad, American Toad, Western Toad, Great Plains Toad, Canadian Toad
Treefrogs	Tend to be small with smooth skin. Range in color from green to brown and gray. They can be distinguished by the large sticky toe-pads that they use to climb. Treefrogs spend most of their time in the woods, but they are frequently seen in the spring at breeding time in shoreline vegetation near shallow ponds.	Green Treefrog, Gray Treefrog, Barking Treefrog
Chorus and Cricket Frogs	More frequently heard than seen, chorus frogs are tiny, generally green or brown frogs found near shallow bodies of water with clumps of grass or other vegetation used for cover. Although related to treefrogs, this group stays close to the ground and climbs little.	Spring Peeper, Ornate Chorus Frog, Western and Pacific Chorus Frogs, Little Grass Frog, Northern and Southern Cricket Frogs
Spadefoots	Smooth skin with scattered bumps and a characteristic small, sharp-edged "spade" on each hind foot. The spade is used for digging underground during dry weather. Generally found in dry, sandy, or loose soil. Can be distinguished from other toads by their vertical pupils. Spadefoots emerge with spring rains and head for breeding ponds or vernal pools for breeding. Take care when handling them, because many people have allergic reactions to their skin secretions.	Western, Plains, Eastern, and Couch's Spadefoot

News Notes

BRAME RECEIVES PURDUE ACHIEVEMENT AWARD



From left: Dr. Cal Bigelow, Bob Brame, Dr. Zac Reicher.

Bob Brame, director of the USGA Green Section North-Central Region, was awarded the Purdue University Agronomic Achievement Award from the Agronomy Department on October 25, 2008. The award was established in 2000 to recognize and honor alumni and friends of the department for contributions to the industry. Dr. Zac Reicher, professor in Purdue's Department of Agronomy, states, "Bob is very deserving of this award because of his never-ending generosity to the golf industry in his region as well as across the country. He has been one of our most popular speakers at the Turf Expo in each of the last 15 years, and he regularly hosts one of our turfgrass students on a week of golf course visits in his region." As a 1972 graduate in turfgrass science from Purdue University and a member of the USGA Green Section staff since 1990, Bob continues to raise the bar for agronomics and professionalism in the industry.

2009 TURF ADVISORY SERVICE FEE

It is an unavoidable truth in today's market — current economic conditions are challenging everyone, both professionally and personally. Golf is no exception, as rapidly rising costs of fertilizers, seed, water, and added delivery surcharges impact all aspects of the industry. The USGA recognizes these challenges, but also is feeling the same economic squeeze in our own operation as we continue to supplement the cost of providing the Turf Advisory Service (TAS) by more than 50%! Since the TAS was established in 1953, we have provided the service for one fee, with no additional travel expenses charged.

In an effort to find a middle ground to help both parties, the USGA is offering a substantial discount to golf courses that pay their annual TAS visit early in the season. The visit itself can be anytime during the 2009 season, but having a known schedule allows the USGA agronomists to be more efficient and manage their costs more effectively.

The Turf Advisory Service agronomists are the most knowledgeable, respected, and impartial golf turf consultants in the world. Backed by the USGA, the Green Section's services provide:

- Dependable recommendations that course officials can count on.
- Agronomists who know what to look for when checking for problems, and who have seen symptoms countless times, can quickly identify difficulties and offer the best solutions.
- Information that helps golf courses save many times the cost of the TAS visit.

Schedule your visit today by contacting your regional agronomist listed on the inside back cover of the *Green Section Record* magazine.

2009 TAS Fee Schedule: Half-Day Visit – $2,300*
Full-Day Visit – $3,100*

***A $500 discount is offered for visits paid for by May 15th.** These prepaid, discounted visits can be scheduled anytime during the 2009 season.

PHYSICAL SOIL TESTING LABORATORIES

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

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

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

European Turfgrass Laboratories Ltd.
Unit 58, Stirling Enterprise Park
Stirling FK7 7RP Scotland
Attn: Ann Murray
Voice phone: (44) 1786-449195
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Hummel & Co.
35 King Street, P.O. Box 606
Trumansburg, NY 14886
Attn: Norm Hummel
Voice phone: (607) 387-5694
FAX: (607) 387-9499
E-Mail: soildr1@zoom-dsl.com

Hutcheson Technical & Soil Services
8 West Street, South
Huntsville, ON, Canada, P1H 1P2
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Fax: (705) 789-4457

ISTRC New Mix Lab LLC
1530 Kansas City Road, Suite 110
Olathe, KS 66061
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FAX: (913) 829-8873
E-Mail: istrcnewmixlab@worldnet.att.net

Sports Turf Research Institute
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Thomas Turf Services, Inc.
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Tifton Physical Soil Testing Laboratory, Inc.
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2009 USGA Green Section Education Conference

Friday, February 6, 2009
Ernest N. Morial Convention Center
New Orleans, Louisiana

IT'S ALL ABOUT THE ECONOMY! GOOD IDEAS TO HELP YOU TIGHTEN YOUR BELT

Moderator: Ty McClellan, agronomist, Mid-Continent Region

10:05-10:15 a.m.
Water, Water Everywhere
Be aware: The hidden costs of overwatering can cost you in more ways than one.
Darin Bevard, senior agronomist, Mid-Atlantic Region

10:15-10:30 a.m.
Overcome Your Infatuation with Base Saturation — Does It Make Sense to Apply All That Calcium?
Base saturation is being used to make fertilizer and soil amendment recommendations and define where calcium applications may be helpful for turf growth. Understand these ratios to ensure that unnecessary applications are avoided.
Brian Whitlark, agronomist, Southwest Region

10:30-10:40 a.m.
The Cost of Making Wind
Is blowing hot air burning through your wallet? The surprising numbers involved in the installation and annual operational costs of fans.
Patrick O'Brien, director, Southeast Region

10:40-10:50 a.m.
Naturalized Areas: Beauty and the Beast
Developing naturalized areas brings many benefits to the golf course, but beware: maintenance-free it is not!
Jim Skorulski, senior agronomist, Northeast Region, and John Foy, director, Florida Region

10:50-11:00 a.m.
Presentation of the 2009 Green Section Award

11:00-11:10 a.m.
Pipe Dreams — Do Water Conditioners and In-Line Pipe Devices Really Work?
A perspective on the usefulness of in-line pipe devices for water treatment.
Pat Gross, director, Southwest Region

11:10-11:20 a.m.
Form vs. Function: The "Wow" Factor Can Be Costly
With ever-changing economics, it is more important than ever to cost out maintenance procedures while still meeting golfer expectations. This presentation offers suggestions on mowing tactics and the economics of preparing the playing surface.
Keith Happ, senior agronomist, Mid-Atlantic Region

11:20-11:30 a.m.
What the Inorganic Soil Amendments Really Have to Offer
New products are constantly being introduced in the marketplace. What can be expected from inorganic soil amendments used in the field — new construction and daily maintenance?
Bud White, director, Mid-Continent Region

11:30-11:40 a.m.
With a Good Mechanic, It Will Run Forever
Having a good mechanic is vital to any maintenance operation, but keeping equipment past its useful lifespan can bust a budget and prevent the mechanic from focusing on quality-of-cut issues.
Chris Hartwiger, senior agronomist, Southeast Region

11:40-11:55 a.m.
Bunkers: Can Your Golf Course Afford Them?
It's expensive to construct and maintain bunkers to the very high standards many golfers desire.
Jim Moore, director, Construction Education

2009 USGA NATIONAL & REGIONAL CONFERENCES

National Conference

February 6 — Ernest N. Morial Convention Center, New Orleans, Louisiana

Mid-Atlantic Region

February 24 — Country Club of Virginia, Richmond, Virginia
March 10 — Woodholme Country Club, Pikesville, Maryland

Mid-Continent Region

April 14 — Barton Creek Resort, Austin, Texas
December 16 — Overland Park Convention Center, Overland Park, Kansas

Northeast Region

March 3 — Rhode Island Convention Center, Providence, Rhode Island
March 19 — Hackensack Golf Club, Hackensack, New Jersey

Southeast Region

March 10 — Grandover Resort, Greensboro, North Carolina

Northwest Region

March 3 — Holiday Inn Cody, Cody, Wyoming
March 10 — Lakewood Country Club, Lakewood, Colorado
March 23 — Fircrest Golf Club, Tacoma, Washington

Southwest Region

January 12 — The Victoria Club, Riverside, California
March 16 — Sharon Heights Country Club, Menlo Park, California
March 30 — Tuscany Falls Country Club, Goodyear, Arizona

All Things *Considered*

The New Definition of Golf Course Conditioning

Golf Digest takes a new view.

BY RON WHITTEN

EDITOR'S NOTE: *As most golfers know,* Golf Digest *magazine annually compiles a variety of rankings in the world of golf. The best known is probably their 'America's Greatest Courses,' but they also rank 'Greatest Public Courses,' 'Best Courses by State,' and 'Best New Courses.' The rankings generate tremendous interest, and courses want to be as high in the rankings as possible. The changes in the ranking procedure outlined in Mr. Whitten's article emphasize playing quality over appearance and are very much welcomed by the Green Section.*

Somewhat lost in *Golf Digest*'s comprehensive 30-page examination of the game's role in the environment ("How Green is Golf?" *Golf Digest*, June 2008) was the announcement of a fundamental change in how we at the magazine view course conditioning in our various course ranking surveys. We abandoned the idea that courses should have lush, green, perfectly uniform grass and adopted the position that dry, firm turf provides the best conditions for playing golf.

Here's how that came about. Last winter, architects Pete and Alice Dye, speaking for the American Society of Golf Course Architects (ASGCA), urged us to incorporate an environmental factor into the formula we use to determine our various course rankings (America's 100 Greatest, America's 100 Greatest Public, and Best Courses in each state). Our response was that our surveys evaluate architecture, not club operations, and it would be very difficult to ask laymen panelists to evaluate environmental practices in other than superficial terms. In other words, we weren't going to have panelists start counting bird boxes.

But they persisted, so we asked them what the ASGCA considered to be the single most important environmental issue. "Water use," they said emphatically. We reflected on that and decided it was something our panelists could evaluate, given the right guidance. So we conceived a new definition of Conditioning that has nothing to do with the color green or with the perfection of a lie. Pete, Alice, and other ASGCA members enthusiastically approved. So did *Golf Digest*'s course ranking editorial board.

The old definition of Conditioning read: "How would you rate the playing quality of the tees, fairways, and greens on the date you last played the course?"

The new definition reads: "How firm, fast, and rolling were the fairways, and how firm, yet receptive, were the greens on the day you played the course?"

Our new definition makes it easy for a panelist to evaluate Conditioning just on the basis of his or her golf shots on all different types of turfgrasses. It's intended to encourage water conservation by rewarding courses that don't overwater fairways and greens. (Sensible irrigation is the key: Greens shouldn't be thatchy or squishy, but they shouldn't be so rock hard as to be non-receptive, either.)

Our definition also rewards courses with adequate drainage that allows fairways and greens to be playable in a reasonable time after major rainstorms. It is meant to encourage clubs to forgo winter overseeding, if possible. While recognizing some high-volume winter courses need to overseed to avoid fairway divots, we feel dormant turf can often provide good, firm playing conditions, so our definition rewards courses that avoid purely cosmetic overseeding.

Unlike our old definition, the new one doesn't mention tee boxes. In the past, many panelists scored a course lower if its tee boxes were full of divots. Our editorial position has long been that golfers, not club employees, should replace or fill divots, so it was unfair to penalize a course for the thoughtlessness of its patrons. Likewise, the old emphasis on tees unfairly rewarded courses that received extremely light play and therefore had flawless tee boxes (as well as flawless fairways and spotless greens).

Neither the old nor the new definition ever mentioned rough or bunkers. Our position has always been that rough is meant to be rough, and bunkers are hazards in which no golfer should expect optimum lies.

We circulated this new definition to thousands of golf courses that are candidates for a *Golf Digest* ranking, and the response has been overwhelmingly positive. Most superintendents and course officials agree that drier turf is usually healthier, less susceptible to diseases, and provides more roll to tee shots and smoother surfaces for putting. They like that it embraces a more frugal British approach to turf management that seems recession-proof. Less water means lower electric bills for high-volume pumps and less fuel for mowers used less often.

We think every course would benefit by adopting our definition as its new standard for course conditioning.

RON WHITTEN *is senior editor of architecture for* Golf Digest *magazine.*

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Turf *Twisters*

Q: We have a golf course that gets so wet during the winter months that we cannot even get mowers out to cut the roughs for several weeks. We cannot afford the amount of sand topdressing and drainage needed to make the roughs mowable, so do you have any other ideas? (Washington)

A: Scott Stambaugh, superintendent of Overlake G&CC, has found a perfect answer to your question. He found that lightweight power bunker rakes can operate virtually anywhere without leaving tire marks. His mechanic then built a lightweight towbar that tows three lightweight homeowner lawn mowers to create his own triplex rough mowing unit. Mr. Stambaugh now reports that nine holes can be mowed daily using his "wet set" of mowers regardless of how wet the roughs (or fairways) may become.

Q: Our club uses temporary tees during the winter months. Surrounding clubs continue to use their regular tees for winter play. Is there a general recommendation for closing tees during the winter? (Maryland)

A: No. If your regular tees are used, they will likely show signs of damage through the winter and into spring. Temporary tees help to limit damage to regular tees during a time of the year when the grass is not recovering. However, many golfers grumble about temporary winter tees. If the regular tees are to be used when the grass is not growing, there needs to be an understanding that areas of the tees will still show signs of damage during the early part of the golfing season until the grass begins to grow enough to provide recovery or until these areas are sodded if damage is severe.

Q: We are required to stay on cart paths at times during the winter play season. Do carts really have a major impact on our turf?

A: Yes, especially during the winter play season. Bermudagrass is a warm-season turfgrass and its growth decreases as soil temperatures drop below 65°F. The winter play season often exceeds 200 rounds per day for several months. When such conditions occur on semi-dormant grass, it can cause significant thinning. This can be easily seen by comparing par-3 holes, where cart traffic is limited, to other holes throughout the golf course. Utilizing ropes and stakes or a rotating *resting hole* program are unpopular with many golfers but can significantly improve turfgrass quality.

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