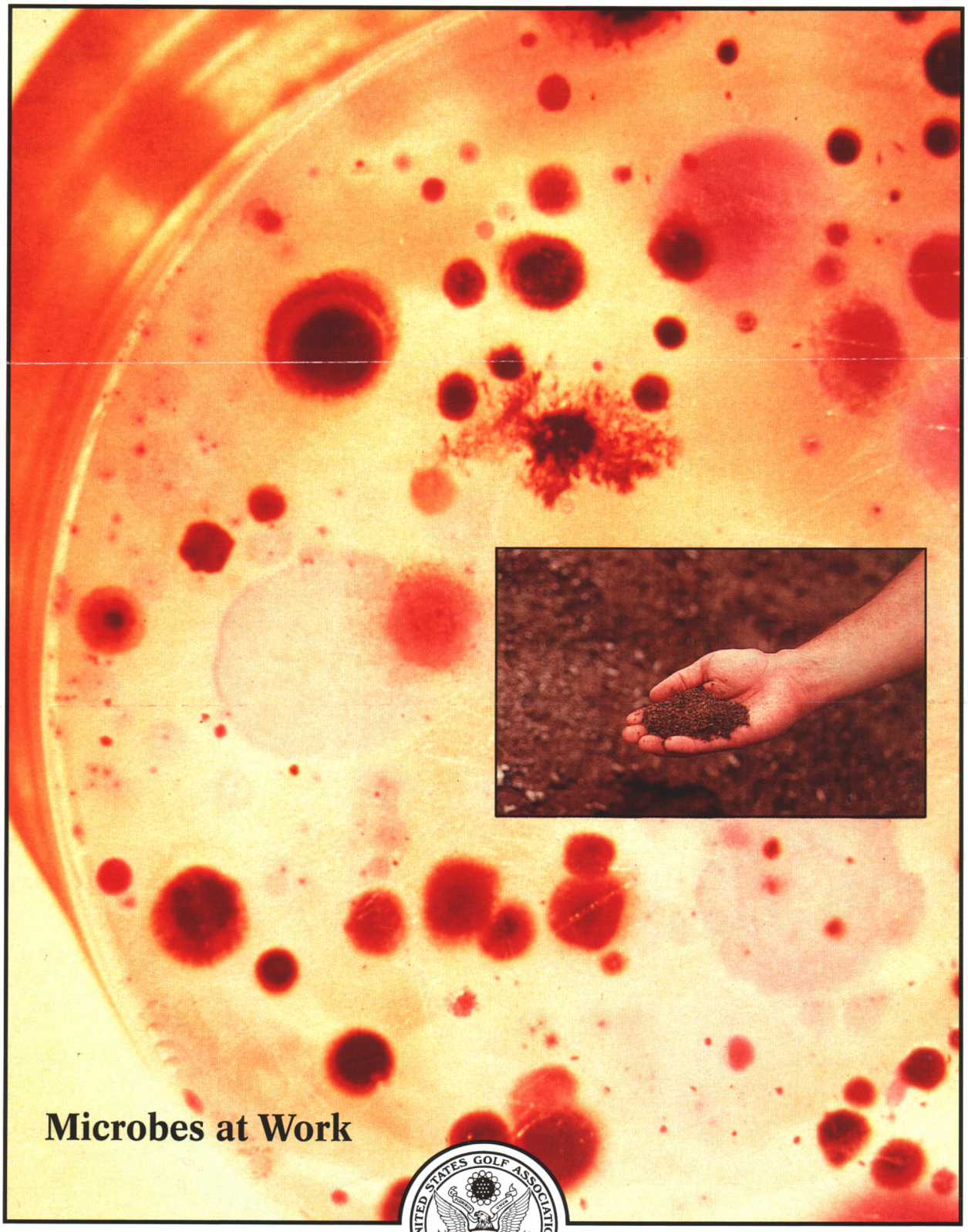
USGA® GREEN SECTION
Record

Volume 36, Number 4 July/August 1998



Microbes at Work

A PUBLICATION ON TURFGRASS MANAGEMENT BY THE UNITED STATES GOLF ASSOCIATION®

JULY/AUGUST 1998
Volume 36, Number 4

Cover Photo: Microorganisms perform vital functions to help sustain life on Earth, including organic matter decomposition and nutrient cycling.

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Sod production of buffalograss has been very successful, with more than 500 acres currently in production. See page 6.

A better root system can be maintained by managing the factors that can be controlled and understanding the impact of the others. See page 8.

THE MICROBIAL WORLD

The role of this dynamic community in turfgrass management has raised a variety of opinions, questions, and products.

by MATT NELSON

THE SOIL microbial community consists of a wide array of organisms with numerous and many yet-to-be-understood complex interactions (14). Although studies of soil microbiology have been conducted for decades, scientists have recently made considerable progress in furthering our understanding of microorganisms and their function in soils supporting turfgrass growth. Public outcry and opposition to the use of synthetic fertilizers and pesticides have prompted much of the recent research. While very useful findings have been obtained through many painstaking and novel research strategies, these studies have yielded the realization that considerably more research will be necessary to develop solid recommendations for managing soil microbial populations. This article will review soil microbiology and discuss how to select and investigate the use of various products and management techniques. The intent is to provide information for golf course superintendents and other turfgrass managers so they can objectively evaluate the plethora of products that claim to produce better turf by influencing soil microorganisms.

Composting is an excellent means of recycling organic wastes. Studies indicate that composts introduce stable microbial components and provide habitat for indigenous microbial populations, and can improve turfgrass health and suppress certain fungal diseases.

Soil Microbiology

A productive, biologically active soil can contain as many as 45 quadrillion microorganisms in the rootzone of 1,000 square feet of turfgrass (19). This population consists primarily of bacteria, actinomycetes, fungi, and algae. Within each of these groups of organisms are many diverse genera and species whose populations fluctuate widely both spatially and temporally. Among the factors contributing to this variation are energy sources, nutrients, water availability, temperature, pH, atmosphere, and the genetics of the organism (6). The result is a very complex and highly competitive system influenced by a combination of biotic and abiotic forces. The specific function and characteristics of the constituents of the microbial community are not straightforward and are not thoroughly understood.

Fungi are involved in organic matter decomposition, mycorrhizal associations, and turfgrass diseases. Mycorrhizal associations are known to improve nutrient and water uptake, and also stabilize soil aggregates. In fact, mycorrhizal associations have been shown to provide interspecific transfer of phosphorus and other nutrients (3). Endophytic fungi form associations with plants and discourage insect predation. Actinomycetes decompose organic matter, particularly complex organic molecules such as cellulose and chitin. Actinomycetes are also capable of producing antibiotics that may confer disease-suppressive qualities (15, 22).

The bacterial populations in soils contribute a range of benefits to plant growth. Included in these are nutrient cycling, soil aggregation, solubilization of immobile elements, competition with pathogenic organisms, organic matter decomposition, and the production of phytohormones. Bacterial populations and their associative functions are diverse and highly significant to plant productivity. Bacteria tend to utilize simple organic compounds, such as plant exudates, while fungi and actinomycetes are more proficient users of complex organic compounds (6).

Much of the activity described above occurs in the region of the soil environment influenced by roots, known as the rhizosphere. Within this region from the root surface outward approximately 10mm is found enhanced nutrient cycling, exudates that affect pH, redox potential, and nutrient availability; symbiotic associations with soil microbes; colonization by microorganisms; interactions with roots and pathogens; and metal mobility and complexation. More simply put, this region is the dynamic interface between plants and soil where microbial function is in action.

Grasses have a significant amount of rhizosphere due to their fibrous and extensive root systems. Although our understanding of the organisms, processes, and dynamics is increasing, there has been relatively little discovered that would enable turf managers to exploit the rhizosphere for improved turfgrass health. Researchers have, however, used mineral nutrition to affect rhizosphere pH and control root-infecting pathogens (4, 23). Beyond this, there is a host of unsubstantiated product claims that purport to favorably affect rhizosphere processes. In turfgrass systems, there is a significant lack of research to validate these claims, not the least of which include the lack of repeated studies and findings at diverse sites or across a variety of soil systems.

Most soils supporting turfgrass growth contain a very active and diverse microbial population. Some people have alleged that the use of synthetic fertilizers and pesticides reduces or eliminates the microbial community by altering the pH of the soil or causing direct and indirect toxicity to organisms. Except for the presence of inert ingredients in some emulsifiable concentrate formulations that have caused toxicity, preliminary results from one ongoing study indicate that pesticides do not adversely affect most non-target microorganisms (16).

Due to the high productivity and rapid turnover of turfgrass roots, as well as the high lignin content in the stems and leaves, organic matter and microbial habitat are rarely deficient in turfgrass systems (12). The one system that may limit microbial activity due to a lack of favorable habitat is a newly constructed high-sand-content rootzone, likely due to reduced nutrient- and water-holding capacity. Keep in mind, however, that the advent of the sand rootzone system and sand topdressing arose to address severe agronomic difficulties, namely soil compaction and poor drainage of native soil greens. Sand-based rootzones have created physical characteristics that allow golf course superintendents to provide superior playing conditions and also maintain an oxygenated rootzone. Microbial populations generally will stabilize 3-5 years after establishment, so amendments to the sand that can facilitate a more rapid colonization of the rhizosphere should lend stability to the system (6). These amendments would include various organic types, including composts and/or inorganic amendments. The challenge of establishing turfgrass on new, sand-based rootzones could be due in part to the lack of sufficient microbial activity to buffer the system from environmental extremes and harmful pathogens.

Soil Management and Microbial Enhancement

Testing for Soil Microbes

Undisputed is the important role microorganisms play in plant and soil health. The difficulty is in quantifying and qualifying that role. Recent advances in molecular testing capabilities have enabled fairly accurate quantification of the microbial component in soils. While this will not yield a clear understanding of the diverse function and interaction of the various organisms, it is a beginning point for assessing microbial health in soils. Keep in mind that microbial populations fluctuate widely across sites and over the course of a season, however, so testing for microbial activity may produce somewhat confusing results until a large enough database can be assimilated. This currently may not be feasible or cost effective, and it will certainly take time. However, microbial testing may provide comparisons of soil that supports healthy turf versus soil struggling to support turf. Be sure to account for other factors that may be limiting growth, such as sunlight, air circulation, drainage, fertility, traffic flow, etc. (13). Soil testing for microbes may help assess whether microbial activity is influencing turfgrass quality.

Biostimulants

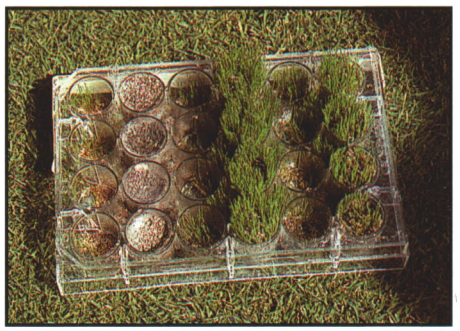
Biostimulant is a loose term that includes microbial inoculum, energy sources for microbes, soil conditioners, plant hormones, and other non-nutritional growth-promoting substances. In recent years, products containing both biostimulants and fertilizers have further muddled this definition. This makes differentiating between fertilizer response and biostimulant response difficult, if not impossible. No doubt this is precisely what the manufacturers of such products have intended, since the non-nutritional component alone may not elicit a plant response.

One group of biostimulants is plant hormones. These products may contain one or more of the following: cytokinins, gibberellins, auxins, abscisic acid, and ethylene. When growing under normal conditions, plants have adequate levels of hormones for normal growth and development. Most physiological processes in plants involve an interaction of several hormones, and individual hormones have several functions. Further, many hormones have different functions in different plant species (8).

Normal hormone production can be influenced by environmental and cultural stress. Different species of plants, growing in different environments, with different stresses, at different times of the year are quite likely to react in different ways. One of these different reactions will undoubtedly be with hormone regulation, and this is consistent with the variability in plant response to hormone applications in research results and field trials across the country. There currently is no evidence to suggest that applications of plant hormones will yield favorable or consistent results with respect to improved plant health. Furthermore, adding hormones to plants beyond normal levels may produce an inhibitory or undesirable effect. Without research information to identify and quantify treatment regimes, it may be wise to avoid tampering with plant hormonal activity (7). Anecdotal evidence and testimonials have been the substitute for independent research results repeated at multiple locations.

Another type of growth stimulant available on the market contains humate or humic acid. These are naturally occurring organic compounds that are the end products of biological decomposition. Accordingly, they are extremely resistant to further decomposition. Products containing humates claim to increase cation exchange capacity, increase microbial activity, and chelate micronutrients. Kussow reviewed manufacturer recommendations for amending a sand-peat rootzone mix with humate and found it to be a very expensive means of increasing the CEC by 13% (9). His review further concluded that iron, copper, manganese, and zinc are rarely deficient in turfgrass soils, thus enhancing micronutrient availability may only provide negligible benefits. Another study clearly demonstrated that since humates are the end result of decomposition and thus resistant to further breakdown, they do not stimulate increased microbial activity (25). Yet another study reviewed the effects of six non-traditional growth-promoting products on the establishment of creeping bentgrass in high-sand-content rootzones. Only one of the products produced significant differences from the control, and the product contained humate. Upon chemical nutrient analysis of the product, however, it was discovered to contain 6% N, 5% P, 2% K, 4% S, and 4% Fe. Using this product at the recommended application rate was equivalent to applying an additional 0.75 pound N, 1.3 pounds of P, and 0.34 pound of K per 1,000 square feet per month (27). It may well be that this response could have been duplicated with conventional fertilizer, and it would seem to request an independent nutrient analysis of any growth-stimulating products you intend to try.

Finally, there have been studies that indicate humates and humic acids can reduce the efficacy of pesticides by reducing their absorption by plants and pathogens (9). It is also reported



Some microorganisms found in certain composts can inhibit turfgrass diseases such as Pythium. *Biological control of turfgrass diseases has proven successful in laboratory studies, but has not been consistently successful in field trials.*

that the fulvic acid component of humates can actually increase the solubility of pesticides and possibly increase mobility (25). Most of the studies that claim any benefit from adding humates were in either nutrient culture or sand culture systems, not in field situations. The variation in humic substances from different sources and lack of research that supports their use on turfgrasses currently do not justify their use in turf management.

Carbohydrate fertilizers, another biostimulant, have not been proven to improve turfgrass stress tolerance or have any lasting impact on soil microbial populations. Again, research on turfgrass and carbohydrate application is lacking, but observations across the country indicate no observable benefits. Any stimulation of microbial activity is likely to be very short-lived.

Microbial Inoculants

Various microbial inoculants have been formulated for use on turfgrass, with claims of accelerated organic matter decomposition, improved nutrient use efficiency and availability, soil conditioning, disease control, mycorrhizal associations, and others. The success of these inoculants has been limited for a number of reasons. At this point, you should be aware that the microbial community is a very diverse and complex set of organisms. The degree of natural competition, antagonism, and predation limits the successful establishment of introduced species. Persistence of applied organisms is further hindered by the continual temporal and spatial fluctuation of microorganism populations (6). Formulation and delivery of the organisms present even more problems for microbial inoculation (15). If the organisms can be kept alive until application, many are sensitive to UV light and must be applied frequently (in some cases nightly) to establish sufficient populations. Although there have been efforts to apply microorganisms through irrigation systems, the results remain largely inconsistent (2). Finally, some companies will not even list what organisms they have formulated, because they are proprietary. Without knowing what is being applied, it is impossible to gauge the potential benefits. These organisms could be detrimental to your turf by actually competing with the beneficial organisms already present in your soil (7)!

Composts

With little doubt, the most promising method of managing and enhancing the activity of soil microbes is with composted organic matter in wastes and other materials. Ironically, this is also one of the oldest agricultural practices. Composts have been shown to add an active microbial component to soils and to stimulate those microbes already present in the soil (14). Well-decomposed organic matter provides excellent habitat and energy sources for soil microbes, and will provide more permanent benefit than inoculation with microorganisms. Composts will effectively enhance soil aggregation, provide nutrients, reduce compaction, and improve soil porosity. Sandy soils amended with compost will exhibit greater nutrient- and water-holding capacity (10). While limited evidence exists, there is some data to suggest amending sand-based rootzones with compost can offer improved establishment and disease control over commonly used peat amendments (5, 14).

The use of composts in turfgrass management presents a viable means of recycling municipal and industrial wastes while improving turfgrass quality. Composts can vary considerably, however, depending on their source. Commonly used composts include brewery sludge, yard wastes, poultry litter, animal manure, municipal wastes, and food wastes. It is recommended to have composts tested for organic matter content, ash content (especially if used as a topdressing), moisture content, pH, nutrients, metals, and soluble salts (10). On-site composting operations should follow guidelines to ensure that the material has been properly and sufficiently composted (14, 20, 28). The disease-suppressive characteristics of composts will be discussed in the next section.

Biological Pest Control

In recent years, considerable focus has been placed on the biological suppression or control of various turfgrass pests, including diseases, insects, and weeds. Reducing the pesticide load on the environment is the primary impetus behind such study. While research has proven effective pest control with various biological entities in the laboratory, few have proven consistently effective in field studies.

Biological control operates on five basic interactions with the turfgrass-soil community: competition, antagonism, predation, parasitism, and pathogenicity (1). The two ways of exploiting these interactions include microbial inoculants and organic amendments. While dozens of organisms with potential as inoculants for disease control have been studied (17, 18, 24), few have demonstrated any efficacy in the field, and only one product (Biotrek 22G, *Trichoderma harzianum*) has been registered for disease control on turf (11, 15). Biological control of insects has been somewhat successful in recent years with such organisms as entomogenous nematodes, soil bacteria and fungi, although registered products are still limited (21, 26).

Serious shortcomings exist in the understanding of the pest control mechanisms themselves, relationships with other organisms in the community, and formulation and delivery technology. Furthermore, foliar disease control with inoculants is limited due to UV sensitivity of the organisms and wide fluctuations of environmental parameters in the turfgrass canopy. The difficulty in delivering organisms to the roots has preempted much success in controlling root diseases. Because successful pest control typically depends on the establishment of high population levels, frequent (and arguably unsustainable) applications become necessary. Injecting organisms through irrigation systems has yet to be proven as an effective method of uniform and consistent microorganism application. Keep in mind that 1) population interactions within the soil are dynamic and interrelated, 2) introduced organisms are slow to colonize habitat and generally fail to persist, and 3) it is unclear whether the introduction of microbes in the environment will produce a lasting change and if the introduction will be beneficial in the long run (1, 15).

Organic soil amendments and additives, particularly compost, have per-

Evaluating Independent Research

- Who (principal investigator) did the research?
- Where was the work done (lab or field, sand or soil)?
- Look for replication, good comparative treatments, and statistically significant differences.
- Have the results been duplicated at another site by another independent researcher?
- Have the results been published in a refereed journal?
- *Slick brochures can be confusing!!!* Don't be fooled by sales techniques.

haps a greater potential for effective biological control of diseases than do inoculants. Well-composted material (2-3 years) often exhibits disease-suppressive characteristics (14). Studies at Cornell University have demonstrated significant and lasting disease suppression of *Pythium* root rot, dollar spot, and snow mold when composts were used as amendments or topdressing (14). Continued research in this area to reveal the microbiological mysteries should help develop more reliable and predictable composts for disease suppression and soil conditioning. As alluded to earlier, proper composting techniques and laboratory testing coupled with on-site testing will reveal what to expect from composts.

New Products

Never before has the turfgrass industry had as many commercially available products for use. Financial responsibility and sound management dictate that product purchasing decisions are of extreme importance. So how does one choose between the good, the bad, and the ugly?

The first place to start is with the product label. There are products that have been registered with the EPA and can legally justify the claims of the product. These are products that contain active ingredients (29). There are unregistered products marketed for various uses, some of which are supported by independent research. Then there are products marketed for various uses without supportive research. These products use testimonials and fancy marketing to make a sale, and often can be classified as snake oils.

Let's be sure we understand the independent, scientific research that supports product use. Be sure you know who conducted the research, where, under what conditions, and the relevancy to turfgrass systems. Also, look for replication in the study, good comparative treatments, and least significant differences. Check closely to see that the results have been duplicated at another site by another independent researcher, and that results have been published in a refereed journal. Make no mistake, slick brochures and displays can be confusing! One product advertisement I recently reviewed claimed the product would cause no grow-in layer, extend the useful life of greens, reduce grow-in time, eliminate the possibility of nitrite (yes, they said *nitrite*, not *nitrate*!) and phosphate leaching, and reduce labor, among other things. This company may need legal counsel as much as scientific counsel. Finally, call the researchers and ask technical representatives what the active ingredients are and what are their modes of action (29). University extension personnel and USGA agronomists can also provide valuable information.

If a product you are interested in passes this initial screening, it is strongly recommended to conduct on-site testing at your golf course. Many of these products are not cheap, and good management involves an economic analysis. Test the material at several locations on the golf course representative of different conditions, replicate (meaning include repeated treatments at each site), and use untreated controls and other treatments in side-by-side comparisons. All too often, new products are tried all over the golf course without a control; thus, it is impossible to determine what effect, if any, the new product has. Perceived benefits could be a result of favorable weather or other management techniques (7, 13). Take consistent, monthly ratings of the plots for color, disease, and rooting depth and mass, and note stress tolerance differences. Good tests require at least two years of field data. Because a product will cause no harm is not reason to use it, and such a decision is representative of poor management.

Conclusion

Turfgrass management is a continually evolving science, and as our understanding of the microbial community in turfgrass systems improves, new products will routinely hit the market. Some of these products will be useful, and many others will not. Independent research will be essential to the development of effective products. Perhaps companies marketing biological products would be wiser to fund some research than to purchase full-page ads in popular trade magazines (if they have faith in their products)!

If completely organic management is ever realized, it will certainly be through a gradual phase-out of synthetic products. Along with the advent of biological products, golf course

On-Site Testing Protocol

- Test products at several locations representing different conditions on the golf course.
- Replicate at each site for best results.
- Use controls (no product) to establish comparisons.
- At least two years of field data are necessary to obtain an accurate assessment.
- Rate the plots monthly to track differences (color, disease, stress tolerance, rooting, etc.).
- Conduct an independent nutrient analysis of new products. You may be seeing a fertilizer response!
- Be honest! Is it the product or favorable weather, better cultivation, an improved growing environment, or other changes in management strategies?

superintendents must also keep themselves apprised of advances in synthetic chemistry. Many new products have been developed from synthesized organic compounds that are effective at very low levels of active ingredients, have low water solubility, short half-lives, and a strong binding potential with soil and organic matter. The new synthetic chemistries are better for the environment than many of the older chemistries.

The importance of a strong microbial community cannot be questioned. The effectiveness of various products available to stimulate microbial activity *can* be questioned. Become familiar with soil microbiology and processes, check for duplicated independent research to support product claims, and test the material yourself to be sure it is effective and makes good economic sense. But whatever you do, don't forget the basic tenets of successful turfgrass agronomy: adequate sunlight, drainage, air circulation, proper fertility, good water management, traffic control, and cultivation.

MATT NELSON *is an agronomist in the Northeast Region of the USGA Green Section. He "bugs" superintendents to take a close look at product purchasing.*

Soil Microbes

Bacteria	Single-celled organisms without a nucleus. Perform an important role in organic matter decomposition, nutrient cycling, soil aggregation, competition with pathogens, production of phytohormones. Also form symbiotic associations with plants.
Actinomycetes	Filamentous bacteria. Decompose complex organic matter molecules like chitin and cellulose, produce antibiotics, and regulate bacterial populations.
Fungi	Very good degraders of organic matter. Mycorrhizal and endophytic fungi form beneficial associations with plants. Most turfgrass pathogens are fungi.
Algae	Autotrophic organisms. Some fix nitrogen. Excess nutrients can result in an unwanted bloom.
Protozoa	Important in nutrient cycling and organic matter decomposition. Feed on bacteria and control bacterial populations.

Literature Cited

1. Berndt, W. L. 1996. Population interactions: the key to unlocking natural pest control. *The Turf Letter.* 1(3):1-8.
2. Bresnahan, J. 1998. Bioject: results of 1997 research trials. *Presented at New England Regional Turfgrass Conference and Show.* Providence, RI. March 4, 1998.
3. Chiariello, N., J. C. Hickman, and H. A. Mooney. 1982. Endomycorrhizal role for interspecific transfer of phosphorus in a community of annual plants. *Science.* 3:941-943.
4. Dernoeden, P. H. 1987. Management of take-all patch of creeping bentgrass with nitrogen, sulfur, and phenyl mercury acetate. *Plant Disease.* 71(3): 226-229.
5. Hall, R. 1996. Composts vs. peats: composts win. *Landscape Management.* 35(8):14.
6. Holl, F. B. 1997. The mysterious world of the turfgrass root zone. *Turfgrass Trends.* 6(11):1-8.
7. Isaac, S. 1998. Bio-stimulants and all that! *International Turfgrass Bulletin.* 199:9-10.
8. Karnok, K. J. 1989. The use of plant hormones as non-nutritional turfgrass growth enhancers. *Golf Course Management.* 57(7):28-38.
9. Kussow, W. R. 1994. Humate and humic acid. *The Grass Roots.* 22(2):18.
10. Landschoot, P. 1998. Using composts to improve turf performance. *Turfgrass Management in the Pacific Northwest.* 1(1):32-34.
11. Lo, C. T., E. B. Nelson, and G. E. Harman. 1996. Biological control of turfgrass diseases with a rhizosphere competent strain of *Trichoderma harzianum. Plant Disease.* 80(7): 736-741.
12. Loomis, R. S., and D. J. Connor. 1992. *Crop ecology.* Cambridge University Press, New York, NY.
13. Moore, J. F. 1997. Let's give credit where credit is due. *USGA Green Section Record.* 35(2):20.
14. Nelson, E. B. 1996. Enhancing turfgrass disease control with organic amendments. *Turfgrass Trends.* 5(6):1-15.
15. Nelson, E. B. 1997. Biological control of turfgrass diseases. *Golf Course Management.* 65(7):60-69.
16. Nelson, E. B. 1998. Turfgrass pesticides and biological disease control: are they compatible? *CUTT.* 8(4):7-9.
17. Nelson, E. B., and C. M. Craft. 1991. Introduction and establishment of strains of *Enterobacter cloacae* in golf course turf for the biological control of dollar spot. *Plant Disease.* 75:510-514.
18. Powell, J. F., M. G. Nair, and J. M. Vargas, Jr. 1994. Utilization of a bacterial metabolite for the management of dollar spot disease of creeping bentgrass (*Agrostis palustris*). *Phytopathology.* 84(10):1077.
19. Roberts, E. C. 1998. Turf research: nature, needs, and net results. *Turfgrass Trends.* 7(1):1-9.
20. Senseman, R. Y. 1995. Composting: turn your eyesore into black gold. *USGA Green Section Record.* 33(3):8.
21. Shetlar, D. J. 1996. Field testing of biological pesticides. *Turfgrass Trends.* 5(8):1-9.
22. Stockwell, C. T., E. B. Nelson, and C. M. Craft. 1994. Biological control of *Pythium graminicola* and other soilborne pathogens of turfgrass with actinomycetes from composts. *Phytopathology.* 84:1113.
23. Thompson, D. C., B. B. Clarke, J. R. Heckman, and J. A. Murphy. 1994. Suppression of summer patch in turf with acidifying nitrogen fertility programs. *Phytopathology.* 84(10):1085.
24. Thompson, D. C., B. B. Clarke, and D. Y. Kobayashi. 1996. Evaluation of bacterial antagonists for reduction of summer patch symptoms in Kentucky bluegrass. *Plant Disease.* 80(8):856-862.
25. Varshovi, A. 1996. Humates and their turfgrass applications. *Golf Course Management.* 64(8):53-56.
26. Villani, M. G. 1996. Biorational control agents for Japanese beetle management. *CUTT.* 7(1):1-7.
27. Wegner, T. 1997. Bentgrass response to non-traditional soil additives. *The Grass Roots.* 25(4):58-61.
28. Zontek, S. 1974. Composting: alchemy in action. *USGA Green Section Record.* 12(3):9-11.
29. Zontek, S. 1997. Buyer . . . beware. *USGA Green Section Record.* 35(1):17.

Low Maintenance Troubles

Research that is helping turf managers maintain buffalograss as a low-maintenance alternative.

by ROCH E. GAUSSOIN, Ph.D.

NAMED AFTER the animal that grazed it, buffalograss (*Buchloe dactyloides*) is a warm-season turfgrass species native to the subhumid and semi-arid regions of the North American Great Plains. It is a long-lived perennial that spreads vegetatively by stolons and, historically, was one of the most widely used species for erosion control and dryland pastures. Buffalograss's low growth habit and exceptional heat and drought tolerance have given it the ability to survive in environments considered too hostile for other species. In the early 1930s, buffalograss was commonly used on non-irrigated home lawns, golf courses, parks, and other turf areas in the central United States.

In the early 1980s, interest in buffalograss began to escalate as the public became more conscious of natural resource conservation and the need for a turfgrass species that would require fewer pesticide and fertilizer inputs while providing an acceptable level of quality. The acceptance of buffalograss as a high-quality, low-maintenance turf has been hindered by the limited number of available varieties and a superficial understanding of its management requirements. In 1984, the USGA Turfgrass Research Committee began funding a breeding project at the University of Nebraska to develop new buffalograss varieties and determine their management requirements.

The first buffalograss plots were established in the spring of 1985. These plots were composed of plants collected by a team of scientists from the University of Nebraska that included Dr. Larry Newell, a forage grass breeder, and Drs. Edward Kinbacher and Terry Riordan. The plants were established in an irrigated field and evaluated for rate of spread, density, and color. To the surprise of those involved with the project, several of the selections had completely grown in by August of the same year and had acceptable turf quality. During the following winter, the selections that had performed well in the field were increased in a greenhouse and, in the spring of 1986, the first replicated plots were established.

In 1989, two vegetatively propagated buffalograss cultivars were ready for release to the public: "Prairie," developed by Dr. Milt Engelke at Texas A&M University, and "609," developed by Dr. Terry Riordan. This event furthered the widespread use of buffalograss in the United States. Ben Crenshaw, a professional golfer, and David Doguet, a Texas sod grower, obtained the rights to produce these two varieties and began marketing them as turfgrasses that were better for the environment.

The marketing efforts of Crenshaw and Doguet resulted in significant sales of buffalograss sod and plugs, and made the public aware of the potential environmental benefits of using buffalograss in areas where traditional turfgrass species were used. For example, based on buffalograss's low water use rate, the cities of Austin and San Antonio began offering rebates to homeowners if they planted or converted their turf areas to buffalograss.

Since the release of Prairie and 609, other vegetative cultivars have found their way onto the market, including northern-adapted cultivars from the University of Nebraska breeding program. In addition, private industry and other university breeding programs have produced several seeded cultivars.

In the late 1980s and early 1990s, fundamental information on optimal mowing height, fertilization rates and timing of application, optimal planting times, etc., was lacking for the improved buffalograss cultivars. As a consequence, many turf managers maintained buffalograss using traditional cultural practices and reported disappointing results. For instance, rather than taking advantage of the low water and nutritional requirements of buffalograss, many established areas were over-irrigated and over-fertilized. This management regime promoted heavy weed invasions and unacceptable turfgrass quality.

In recognition of the absence of fundamental information, the USGA Turfgrass and Environmental Research Committee approved additional funding to develop more comprehensive management recommendations in 1993. This research could not have come at a more critical time for those attempting to maintain buffalograss stands.

Early management research concentrated on establishment techniques.

Fertilization rates play an important role in the results of buffalograss performance. Over-fertilization results in a significant amount of weed competition.

Over-irrigation promotes unacceptable turfgrass quality. In research investigating various irrigation rates, buffalograss (right) was still able to produce a quality turfgrass stand as the irrigation amount was decreased when compared to tall fescue.

Although buffalograss is categorized as a low-maintenance species, it was soon discovered that during establishment it does require irrigation and nitrogen fertilizer at levels comparable to other warm-season turfgrasses. It was also discovered that the primary factor restricting successful establishment was weed competition. Part of this latter problem was that the herbicides routinely used on buffalograss in a pasture system were either not registered for turfgrass usage or were no longer available. This meant that a turf manager trying to establish buffalograss had to either apply products illegally, hand weed, or mow in hopes that cutting the stand would give buffalograss a competitive edge. None of these options were acceptable.

The herbicide dilemma has been somewhat remedied by the registration of the herbicide Plateau, which has shown good promise for alleviating weed competition during establishment of buffalograss. The plant protectant industry has further responded to the dilemma by rewriting existing herbicide labels to include application on buffalograss.

Research on buffalograss management also has focused on determining optimal and sub-optimal planting dates. Kevin Frank, a graduate student at the University of Nebraska, has evaluated seven different planting dates in Utah and Nebraska. This work has shown that buffalograss can be successfully planted anytime from April to July in these locations, and that planting after early August will produce unsatisfactory results.

An evaluation of mowing and fertility requirements of four cultivars (seeded Texoka, seeded Cody, 118, and 378) also was made at the conclusion of the establishment research project. This work shows that some cultivars respond well to fertilizer rates of 2.0 pounds per 1,000 square feet, which is twice as high as what was previously recommended. While this rate is still a lower nitrogen recommendation than what is applied to traditional turfgrass species, it does indicate that the early belief that buffalograss would not respond to nitrogen fertilization is not true of all cultivars. The mowing results indicate that, depending on the end-user's preference, buffalograss can be maintained at ⅝" for a high-quality stand or simply mowed once a year for a truly low-maintenance landscape.

Buffalograss research conducted to date has only scratched the surface of what can and needs to be discovered. The potential of this species as an alternative to traditionally used turf species is indeed tremendous. With this in mind, it is unfortunate that some turf managers, without giving buffalograss adequate time to prove its environmental benefits, have already gotten off the bandwagon.

Currently, buffalograss is being effectively used in home lawns, as golf course rough, in areas that are difficult to mow, and in roadside/industrial areas. As research continues to identify optimal management programs for improved turf-type buffalograss, their use on golf course fairways and other intensively managed areas, especially in locations where water supplies are limited or restricted, should be realized.

DR. ROCH GAUSSOIN *is the Extension Turfgrass Specialist for the University of Nebraska in Lincoln, Nebraska. In addition to his statewide extension activities and continuing work with buffalograss, Dr. Gaussoin is evaluating the results of various putting green grow-in programs as part of a USGA research grant.*

"Where Do My Roots Go In August?"

Managing the factors you can control, and understanding the rest.

by STANLEY J. ZONTEK

GOLF COURSE superintendents know that roots of bentgrass or bentgrass/*Poa annua* greens shorten and die back each summer. And when conditions become hotter, wetter, and more humid, the roots suffer even more, becoming shorter in length and brown in color. These are not good signs to the turf manager who is attempting to maintain putting greens during the peak-play summer golfing season, when the grass already is subject to mechanical, environmental, and disease stresses. It is the purpose of this article to review the factors that cause root dieback during the summer. By understanding these factors, the golf course superintendent may be able to maintain a better root system during the summer.

Factors Associated With Summer Root Dieback

The following factors are listed in order of relative importance in terms of their effects on roots.

Soil Temperature: Of all the factors that affect the loss of roots of cool-season grasses in the summer, soil temperature is the most significant. Research has shown that when soil temperatures approach 85-87 degrees Fahrenheit at a depth of 2 inches, roots of cool-season grasses begin to lose their ability to absorb water and to cool themselves through transpiration. Nutrients, which help to maintain plant health and proper plant functions, also are less readily absorbed. In fact, that's one of the great differences between cool-season and warm-season grasses — their ability to grow under high air and soil temperatures.

Unfortunately, soil temperature is the factor over which the superintendent has the least control. Nevertheless, a few things can be done to help improve the situation. Preliminary research at Kansas State University suggests that roots die back from the surface, where the soil is the warmest, *not* from the bottom up as common sense would suggest. During the past decade, the use of fans on golf courses has increased dramatically. One of the more important functions of fans is to cool the turf canopy and the upper soil layer. The use of fans is one way a golf course superintendent can help maintain the health of the grass and its root system during the summer.

The new systems that blow air into a green and, to a lesser extent, suck air through a green, can reduce soil temperature to some extent. In some cases, even a small reduction in soil temperature can make a difference. Research currently sponsored by the USGA may help reveal the value of air injection in reducing soil temperatures.

Mowing Height: All one has to do is look at a scalped plug from a putting green under summer heat stress to appreciate just how critical mowing height can be in determining whether a grass plant survives a hot and humid summer. Low mowing heights are also a trigger for stress-related diseases, such as summer patch (*Magnaporthae poae*) and anthracnose (*Colletotrichum graminicola*).

Although golf course superintendents have the ability to adjust cutting heights, they often are pressured to lower heights to obtain fast green speeds. It has been shown that just a bit more leaf canopy can help keep the surface of the soil cooler and help the grass survive. It is important for golfers to understand that mowing grass too closely during the summer is not a good practice, especially when the turf on the greens is *Poa annua* and/or some of the older bentgrass varieties.

In the final analysis, as it pertains to maintaining ultra-low mowing heights and fast green speeds, the old adage may be worth repeating — slow grass is better than no grass.

Irrigation/Over-Irrigation: Simply put, wet soils become hotter soils because water is a good conductor of heat. Although wet soils may take longer to heat up, they also retain heat for longer periods. Too much soil moisture also is associated with a depletion of soil oxygen, which contributes to root loss problems.

The golf course superintendent can't control how much it rains, but she can control how much water is applied through irrigation! The amount of water in the soil has a major impact on summer root decline. Water replaces soil oxygen and this can lead to anaerobic soil conditions, including black layer. Diseases such as brown patch and *Pythium* also are favored by higher levels of moisture. Longer wet/dry cycles work well on more modern greens that drain. On mineral soils that do not drain as well, lighter, more frequent applications of water are best for maintaining the right balance. During the summer, it is always better to water less . . . it's easier to add more water than to remove an excess, especially in soils that just do not drain very rapidly.

Mechanical Damage: Mechanical injury to the grass affects its ability to survive a hot summer. Replace grooved rollers with solid or section rollers. Use floating-head mowers versus fixed head walk-behind mowers and switch from triplex mowers to walk-behind units. *Do not mow greens when they are too wet*, and defer topdressing, vertical mowing and routine grooming operations until temperatures cool and the grass and its root system are under less stress.

Many turf managers and golfers seem unaware of how much mechanical injury can contribute to the decline of roots during the summer. It is a factor that can be controlled but is too often overlooked.

Nematodes: Nematodes sometimes cause root-loss problems, especially in the more southern parts of the country where bentgrass is grown on greens. It should be emphasized that plant parasitic nematodes occur naturally in most soils. But please, do not dash out to treat all of your greens routinely for nematodes unless there is a demonstrated need for these applications based on soil nematode assays. If a problem exists, know that parasitic nematode problems *seldom occur evenly or equally in all greens.* Hot

spots of nematode activity occur. It takes a good scouting program to identify nematodes as a problem, especially in the central, transitional, and/or more northern regions of our country.

A well-thought-out nematode control effort usually begins by reducing other plant stresses by increasing the mowing height or careful attention to syringing, for example. Nematicides are among the most toxic products applied to golf course greens, and their use can be justified only if a significant problem exists. Nonetheless, when factors are considered that can affect the loss of roots in summer, nematode activity should be mentioned even though control measures may not always be justified.

Disease: Soil-borne diseases like *Pythium* can be placed in the category of only *occasionally* affecting the root system. There has been much confusion over the years about *Pythium* problems on greens during the summer. Keep in mind that *Pythium* is ubiquitous . . . it's always in the soil and is a common inhabitant of grass roots. Nonetheless, many fungicide applications are made to greens in the (sometimes futile) attempt to control this naturally occurring soil problem.

The key questions to ask are: Are these *Pythium* species aggressive parasites actively colonizing healthy, live tissue? Are they non-aggressive parasites living in the upper few inches of soil? Or are they saprophytes? It takes an experienced plant pathologist to tell the difference. In my opinion, many of the *Pythium* root dysfunction and root rot problems identified are secondary in nature and occur on tissue, including roots, that is declining due to other stress-related factors. Although a good preventive fungicide spray program is always a good idea, keep in mind that chemicals alone will not keep grass alive during the summer. They should be part of an integrated program that includes reasonable mowing heights, lightweight hand mowing, reduced mechanical stress from grooming and topdressing, the use of fans, weekly to biweekly applications of light rates of soluble fertilizers, and avoidance of over-watering.

Grass Type: The ability of species or cultivars to tolerate high soil temperatures varies widely. The roots of all cool-season grasses shorten during the summer to some extent, including the newer varieties that have been developed to better tolerate summer heat stress. The difference seems to be the rate at which roots decline and the ability of a variety to tolerate heat stress, regardless of the depth of its rooting system. This is an important point. Visually, the new heat-tolerant bentgrasses may seem to be performing

Maintaining a good root system throughout the difficult summer months is a critical factor for the turf manager. Soil conditions, mowing height, mechanical damage, and irrigation are just a few factors that impact summer root decline. Soil coring is a necessary management tool to maintain good soil aeration resulting in healthy white roots and a healthier plant.

Nematodes can sometimes be the cause of turfgrass root problems. Deformed, swelled roots with bulbous root tips are an indication of potential nematode damage.

better with more grass on the surface of the green, but they have a similar amount of summer root loss in comparison to other species.

Obviously, *Poa annua* also experiences summer root loss problems, including perennial biotypes. *Poa annua*, by its nature, also has lower tolerance to extended periods of heat. That's why *Poa annua* on greens in the deep South functions as a true winter annual, whereas in the upper Transition Zone we routinely see patches of perennial biotypes of *Poa annua* survive the summer. Grass type does make a difference, be it among bentgrass cultivars or annual and perennial biotypes of *Poa annua*.

Determining how these newer bentgrasses perform under actual conditions of play, in comparison to some of the standard, older bentgrass varieties, is one of the reasons the USGA has built 16 demonstration greens across the United States. Stay tuned — the results should be interesting.

Other Factors

Shade Affects Rooting: Proper root development requires an adequate amount of sunlight. Also, shaded and pocketed greens often are wetter greens. There is less evapotranspiration in the shade than in the sun. Thus, if you water greens equally and do not compensate for open and exposed greens versus pocketed and shaded greens, this can cause problems. A combination of higher soil moisture, higher soil temperatures and additional humidity are major causes for the decline of pocketed greens. Proper water management is critical to maintaining quality turf in shaded environments.

Fertility: Putting greens need some fertilizer during the summer. Light rates of fertilizer applied in a soluble spoon-feed type of program work well. The grass is never over-fertilized, nor is it under-fertilized. Such programs help to maintain roots, to the extent possible, by allowing the grass to re-grow roots from the stems and crowns. This regeneration of roots is another natural factor that helps the grass survive.

Soil Compaction: Zones of soil compaction and/or layers can be managed via an appropriate soil coring and aeration program. Keep in mind that roots grow through air spaces in the soil. Without good soil aeration, root depth and density will suffer. During the summer, aeration can be achieved using solid or small ¼-inch hollow tines, surface spiking, and high-pressure water aeration. Used properly, these practices can help to maintain roots and even stimulate new root development.

Preemergence Herbicides: Some people may be surprised about how low on the priority list of factors affecting root dieback the use of preemergence herbicides is. Preemergence herbicides may inhibit or delay rooting for several weeks following their application, but these products should have few long-term negative effects on roots in the summer *if applied at the proper time and at the proper rate in early spring.* However, if a preemergence herbicide application is made late in the spring or is applied at an excessive rate, then direct injury could occur. Furthermore, there could be enough soil residual to inhibit rooting during the late summer/early fall period. Additionally, if one of the long-residual preemergence herbicides is applied to the greens too late in the spring, the residual can affect seed germination during fall overseeding work. Know the residual of your preemergence herbicide and plan accordingly. In some cases, it might be better to skip a preemergence herbicide application and rely upon postemergence sprays or even hand weeding.

Growth Regulators: It has been said that growth regulators neither benefit root growth nor significantly inhibit root growth. Nevertheless, know the properties of the products you are using and plan accordingly. One observation is worth offering: be careful of combining growth regulators with fungicides that have growth regulating side effects. For example, the sterol-inhibiting fungicides, or DMIs, have growth regulator activity and can adversely affect greens on a PGR (plant growth regulator) program. There can be an enhanced PGR effect, especially if the summer is particularly hot, humid, and stressful. This enhanced growth regulating effect can take the form of phytotoxicity and delayed recovery from injury.

In Summary

Always work to stimulate root development in the spring and fall. Aeration, balanced fertility, and reasonable mowing heights all contribute to good root growth. Be sure to have adequate sunlight and air circulation. Be careful with the application of preemergence herbicides, and be on a good preventive fungicide program. Monitor for plant parasitic nematodes and, where appropriate, consider interseeding newer varieties of heat-tolerant bentgrasses into problem greens. All of these programs can contribute to healthier grass and better putting green turf during the summer.

Author's Note

The author would like to extend a special thank-you to Dr. Peter Dernoeden at the University of Maryland for reviewing this article.

STANLEY J. ZONTEK *is the Director of the USGA Green Section's Mid-Atlantic Region. Stan has a B.S. degree in Agronomy/Turfgrass Management from Penn State University and joined the Green Section staff in 1971.*

Golf and Turfgrass Management in Italy

Understanding the infrastructure of the Italian golf industry.

by PAOLO CROCE and ALESSANDRO DE LUCA

PERIODICALLY, the USGA Green Section agronomists are asked to host visiting agronomists from other countries. One such exchange occurred when the Green Section technical staff of the National Golf School of Italy visited the USGA Green Section's Mid-Atlantic region. Their goal was to see how U.S. golf courses are maintained in a climatic region corresponding to where the majority of golf courses are located in Italy. The ultimate purpose of any agronomist exchange is to learn from one another.

In Italy, golf is a time-honored sport. The game was first introduced from England by the Duke of Albany in the early 17th century. The first course was in the Villa Borghese Meadows of Rome; however, the first golf clubs were officially created in the late 1800s.

The first documented club was the Florence Golf Club, established in 1889. The oldest and still-functioning golf course in Italy is the Acquasanta of the Golf Club Roma, created in 1903. Thus, the early development of golf in Italy roughly parallels the USA.

The Italian Golf Federation (FIG) was founded in Milan on May 31, 1927. A year later, it became affiliated with the Italian National Olympic Committee (CONI) and moved its headquarters to Rome. By 1941, the FIG was governing 24 golf courses with 1,000 members. As of December 31, 1997, the Italian Golf Federation had more than 200 golf courses, 35 driving ranges, and 55,000 members.

The distribution of golf courses in Italy is not at all homogeneous. Most of the courses are located in the north, and some occur in the central parts of Italy, mainly in the major cities. There are a few golf courses in the southern part of Italy and on the islands of Italy.

From a technical point of view, almost all Italian golf courses have a high standard of quality. Some have even hosted major international competitions. However, the search for grand and impressive facilities has resulted in the creation of cost-prohibitive clubs and a contribution to the definition of golf as an elite sport. This impression has curbed golf's recent development and growth.

The Italian Golf Federation Technical Center, located at the Golf Club Le Querce, has more than 200 golf course and 55,000 individual members.

Another economic limitation to the success of golf in Italy is the high cost of maintenance equipment. Except for tractors and other commonly used tools like string trimmers, spreaders, etc., the specialized equipment necessary to maintain today's golf courses must be imported. There is no domestic production of such equipment. Most turf care equipment comes from Ransome of the United Kingdom, as well as Toro, John Deere, and Jacobsen products from the United States. As an example, a Toro 3200 reel mower costs about $22,000 U.S. The average cost for a triplex putting green mower, groomer and verticut not included, is $16,000 to $22,000 U.S.

Environmental groups have hampered the creation of new golf courses with allegations of negative environmental impact and pollution. A recent and more rational approach to golf course design, construction, and maintenance has established a dialogue with Italian environmental protection organizations. These efforts also have been instrumental in optimizing maintenance costs and turf quality. As a matter of fact, in the last few years, local authorities have become interested in golf and have directly or indirectly participated in the development of golf courses in Italy. Much of this progress was made possible by the Federal Technical Center of the Italian Golf Federation, which includes a turf section within the National Golf School.

In Italy, the Federal Technical Center — National Golf School was started in 1980 with the aim to organize technical training refresher courses for Italian golf professionals. In its first years of existence, the school used temporary facilities until the construction of its own 18-hole golf course with an independent building for the National Golf School was completed. As a tribute to his country of origin, George Fazio designed this golf course. The golf course is on 173 acres (70 hectares) within 25 miles (40 kilometers) of Rome. By the mid-1980s, the development potential for golf in Italy was considerable, hence the need for training the individuals indispensable in the operation of a golf course — the golf course superintendent and the golf course manager. As a result, three sections were included within the National Golf School. The first section was for golf professionals in 1980, a second for managers in 1987, and the third, the Green Section, in 1989. At present, each of these three sections of the Federal Technical Center has offices, classrooms, a gym, and the internationally recognized 18-hole golf course. This course hosted the World Cup in 1991.

In Italy, it takes five years and several educational courses to become a golf professional. In our country, only a golf professional with a diploma from the Federal Technical Center can teach golfers.

Golf managers (we call them golf secretaries, as in the United Kingdom) are in charge of managing the golf club. They are responsible for the clubhouse

budget and also for the golf course and club in general. Most of them are also referees for golf tournaments.

The Green Section of the Italian Golf Federation carries out the following functions.

- Annual golf course maintenance classes. These classes consist of two four-month theoretical classroom sessions and a third practical session of two months. During this time, the trainees maintain the golf course at the Federal Technical Center. To get the diploma of superintendent, trainees must work on a golf course for at least three years and pass several exams (one each year). There are also one-week refresher courses offered on specific subjects for individuals who have already worked on golf courses.
- Vocational training for maintenance workers.
- Technical supervision of the Federal Golf Course.
- Technical assistance to new golf projects and construction.
- Technical assistance to affiliated clubs through field visits, telephone/fax consulting, and training classes.
- Field research studies at two turf experimental centers, one in Turin and another in Rome.
- Participation in seminars and conferences involving dissemination of information on the subject of golf course and turfgrass management.
- Organizing and updating the most comprehensive turfgrass library in Italy.

The Italian Green Section agronomists were trained at Texas A&M University under the able guidance of Dr. James B. Beard. Dr. Beard also was the main organizer of the Green Section and he still consults with the Italian Golf Federation. Interestingly, up until that time, the subject of sports turf did not appear on the curriculum of any Italian school and had to be created. The Green Section of the FIG bridged this gap, continually updating Italian textbooks. By 1992, the school was judged as "the only such school in the world outside the United States." On the basis of this model, similar schools were established in France, Sweden, and Germany. There is no doubt that the Green Section of the Italian Golf School has become the true technical reference point in the field of turfgrass management in Italy, if not other countries. However, there still is a long way to go.

At present, more than 30% of Italian golf courses are being maintained by professional superintendents with diplomas from the Federal School. In the past, golf courses had been maintained by so-called green wizards who often used their instincts and improvisation, neglecting the scientific and correct techniques.

Golf course design and construction were frequently carried out by various types of individuals — by professional or amateur golfers or landscape designers. Often, the resulting golf course had high maintenance costs due to very poor technical design and construction techniques.

Some courses have been designed and constructed well. Some are world-class for the natural environment in which they have been created and for their design features. However, a look at some golf course construction errors in Italy shows that:

- Greens have been constructed on soils with extremely variable composition. On older golf courses, which account for 20% of our total golf courses, the greens were built on native soil. This construction technique is similar to the push-up type greens built in the United States. Such greens were designed to hold water.

On newer golf courses, greens are built using sand and organic material. Unfortunately, although the USGA guideline system is highly recommended, due to the quality of the materials available, the difficulty in finding materials, their high cost, and also due to mere incompetence, greens are not always properly constructed.

- With Italian climatic conditions, a properly functioning watering system is indispensable in the maintenance of high-quality turfgrass. Most systems in Italy are designed and installed with great superficiality. This is not the fault of suppliers or installation; it is mainly due to budget constraints.
- Another frequent error is the creation of design features for golf courses that are impressive aesthetically but are difficult to maintain. A case in point is sand bunkers with very steep faces, which are subject to continuous erosion. Another is steep grass banks where hand mowing is mandatory and expensive.
- The importance of subsurface drainage on fairways is often underappreciated. Many golf courses in Italy have soils consisting mainly of silt and clay and, after construction, drainage systems have to be installed to correct these problems.
- Often, tees are not designed and constructed to tolerate high traffic.

Turfgrass research is conducted at two experimental centers in Italy.

Torino Turfgrass Research Plots

- Bentgrass (*Agrostis* spp.) cultivar characterizations under putting green conditions. The final report will be presented at the World Scientific Congress of Golf in July 1998.
- Comparative dollar spot (*Sclerotinia homoeocarpa*) susceptibility of 17 bentgrass cultivars under putting green conditions.
- The relative competitive ability of existing bentgrass cultivars to *Poa annua* invasion.
- The potential for use of a plant growth regulator to selectively retard the competitiveness of *Poa annua*.

Roma Turfgrass Research Plots

- Warm-season turfgrass evaluation program. Forty cultivars of warm-season species: bermudagrass, *Paspalum vaginatum* (seashore paspalum), zoysia species, *Buchloe dactyloides* (buffalograss), *Stenotaphrum secundatum* (St. Augustinegrass).
- Cool-season turfgrass evaluation program. Forty cultivars of *Lolium perenne* (perennial ryegrass) and 27 cultivars of *Festuca arundinacea* (tall fescue) under close mowing conditions.

Additionally, the Green Section of the Italian Golf Federation is working in three different directions.

- Education through training courses and seminars.
- Turfgrass-soil technical assistance visitations.
- Editing of construction manuals.

In summary, as the game of golf grows worldwide, exchanges between agronomists become all the more important. This article is an attempt to give a glimpse of turfgass management, education, and the common problems turf managers experience on old and new golf courses in Italy.

PAOLO CROCE *comes from a long line of golf professionals. He is the only one in his family to break tradition and work with turfgrass. He earned his turfgrass specialization at Texas A&M University in 1988. His cousin, Stefania Croce, plays on the U.S. LPGA Tour. He is the Coordinator of the Italian Golf Federation Green Section.*

ALESSANDRO DE LUCA *was one of the first trainees of the Italian Turfgrass School. After his degree at the University of Bologna, he received his turfgrass specialization at Texas A&M University in 1991. He is the Vice Commodore of the Italian Golf Federation Green Section.*

Current testing standards are inadequate in identifying contaminated seed lots. If problems are not detected in a 2.5-gram test (equivalent to a tablespoon), as much as a train car of seed will be sold as weed free *based on this one sample.*

POA TRIVIALIS CONTAMINATION

An increase in testing standards would benefit superintendents.

by MATT LEVY, RST

POA TRIVIALIS contamination in creeping bentgrass continues to be a serious problem in many new golf courses in the northern part of our country. When a superintendent starts to see patches of different-colored grasses appearing in collars and fairways, everyone scrambles to find the sources of the contamination and a solution to the problem. Unfortunately, after the fact, answers to both of these questions are hard to find.

Two years ago, in an attempt to gain information about possible sources of *Poa trivialis* contamination, an independent seed testing laboratory conducted a study and came up with some significant findings. The laboratory, located in Marysville, Ohio, invited ten of the top seed companies in the country to submit bentgrass samples for comprehensive testing. Of the 90 samples the laboratory received and tested, 41 contained *Poa trivialis*, *Poa annua*, or other problem species. Almost 50% were unsuitable for use on most golf course fairways!

These results contradict the theory of some seed company experts who are convinced that existing seeds in the soil are the likely source of the *Poa trivialis* problem. Also at odds with the soil theory of contamination is the fact that much of this *Poa trivialis* found in many fairways appears to be plants of the new improved varieties. Reliable sources report that the color, leaf texture, and growing habits of the plants found in so many new courses are quite different from common *Poa trivialis*. It seems highly unlikely, therefore, that in the few years that the new varieties have been in existence, we would find seeds occurring naturally in the soil of so many golf course sites.

Another significant finding of the laboratory's study demonstrated that current testing standards are inadequate in identifying contaminated seed lots. In the study of 90 samples, only 6 were found to contain problems at the current 2.5 gram testing levels. This is the amount normally used by seed companies and all certification agencies. If a company does not find contaminants in this one sample, about a tablespoon of seed, as much as a truckload or more will be sold as problem-free. It wasn't until the laboratory tested the submitted samples at 50 grams that it was able to identify all 41 samples containing *Poa trivialis* and other unwanted species.

The accompanying table demonstrates the importance of increasing testing amounts.

If the rate of contaminated seed lots is close to 50%, why are companies looking for problems in the soil? Not all are. Many seed companies are aware of the problem and are taking steps to correct it. However, to resolve this issue, some changes may have to be made, including where companies plant their fields, how their fields are inspected, and how they clean, blend, and bag their seed. In the meantime, how will a company market contaminated lots?

You know the present condition of your course and what you want it to look like in the future. Seed plays a very important role in your course's overall appearance. What you plant today is what your guests will see, walk on, putt on, and hit out of in the future. You deserve the best information available to make a wise seed-buying decision. Testing is by far the most dependable, widely used, and economical way to determine the potential quality of any seed lot.

Here are some easy steps you can take to protect your turf from contamination:

1. Ask your supplier to submit a test report based upon a minimum of 50 grams for each lot of bentgrass seed you buy.

2. If they cannot provide you with a test report, ask them to submit a sample to an independent laboratory for a 50-gram test. (Refuse to buy any seed that has been tested at less than the 50-gram level.)

3. When your seed arrives, make certain that every bag contains exactly the same lot number as found on your clear test report.

4. To evaluate seed on hand or for information about other testing questions, call (937) 644-0888 for sample packets and mailing instructions, or contact another independent seed-testing laboratory.

A 50-gram test greatly reduces the risk of planting problems with your golf course seed.

RESULTS OF INCREASING TESTING AMOUNTS OF SEED

	2.5-Gram Test	10-Gram Test	50-Gram Test
Number of Samples Tested	90	90	90
Percent Containing *Poa trivialis*	3	6	30
Percent Containing Other Species	6	17	41
Contaminants Found	*Poa annua*	*Poa annua* chickweed tall fescue	*Poa annua* chickweed ryegrass tall fescue timothy and others

MATT LEVY *is a registered seed technologist and president of Seed Technology, Inc., in Marysville, Ohio. Seed Technology is an independent seed testing laboratory specializing in turfgrasses.*

Poa trivialis *in creeping bentgrass seed is a serious problem in many new golf course projects.* Poa trivialis *from a contaminated seed lot is seen filling in thin fairway areas left by an outbreak of take-all patch disease.*

HOLISTIC MANAGEMENT

A vital tool for golf course superintendents.

by ARTHUR P. WEBER

THE OLD SAYING "if you always do what you always did, you'll always get what you always got" simply does not work to successfully maintain a golf course. Now, more than ever, golf course superintendents must be able to adapt to changing growing conditions, playing criteria, and environmental constraints. But why do some superintendents successfully adapt and others fail? Holistic management offers both a philosophy and methodology to plan for such success.

Conceptually, holistic management is not specific to any particular endeavor or circumstance. It is about perceiving problems within a broad perspective of underlying causes that can be *managed*. It considers the *whole* to be managed and affected by the results, including the people, soil, environment, and budgeting. The *whole* becomes the description of a minimal sustainable unit upon which management decisions must focus. In practice, holistic management is something like a zoom lens, simultaneously able to scan a broad landscape or focus momentarily on certain details, but always maintaining an awareness of interdependencies and the effects of decisions on the whole.

Holistic decisions consider the entire set of requirements that lead to success, unlike most conventional decisions made, which consider only part of the entire set. For example, decisions made solely because of their anticipated lowering of the bottom line may disregard adverse effects upon the quality of play or the health of the ecosystem.

Forming a Holistic Goal

For most, the forming of a holistic goal is a new experience. We've been so busy solving problems that we haven't taken the time to scan the landscape. One solution seems to not quite be in place when another crisis diverts our attention. This is when we're in need of a time-out to form an all-inclusive holistic goal by listing:

1. All the criteria to be satisfied.

2. The actions needed to satisfy these criteria.

3. The conditions and resources available to carry out these actions.

As a practical matter, omit negatives from the goal. Positively stated listings are shorter and remain focused on the desired outcome. Avoid specifics in favor of broader stated options for flexibility in accomplishing the most important features of the goal. In this way the goal is structured to allow success in one part of the goal to support success in another part. At best, we can expect the decisions we make, even with the most up-to-date scientific knowledge available, only to be able to move us, more or less, in the direction of our holistic goal. We should anticipate surprises, monitor changes that result from our actions, and make prompt adjustments if we are to successfully achieve our holistic goal.

Holistic management is about perceiving problems with a broad perspective of underlying causes that can be managed. Decisions consider the entire set of requirements that lead to success.

Science, Technology, and Management

An extensive misunderstanding pervades our culture of how science and technology relate to management. The confusion enters our laws, regulations, expectations, and emotions when we fail to identify the causes of problems and instead treat their symptoms over and over. The treatments then produce new problems and we become dependent on the treatments.

A lesson for holistic managers is to never assume that a recommendation, scientific or otherwise, will be reliable in any one particular situation. Because an average condition seldom prevails, we should manage to reduce the effects of the unexpected. For example, we can stabilize our most basic golf course resource, our soil, which then buffers the effects of rain, drought, heat, humidity, play, et al. Healthy soil improves our chances for success. Although we might plant the most desirable turf varieties, irrigate with a state-of-the-art system, and groom with the latest equipment, we risk squandering time, manpower, and money unless we provide all we can to develop healthy soil. The fertilizers, chemicals, and all the other things we purchase to manage conventionally and expensively may be treating symptoms of a depleted soil. In bad years, problems will not derive from inadequate resources, but, rather, from inherently lifeless soil.

A lesson for holistic managers is never to assume that a recommendation will be reliable in any one particular situation.

You can use the latest equipment to maintain the turf, but you still need to consider factors such as cutting height and soil moisture to achieve the desired end result.

Case Study

A golf course superintendent's listing of the holistic goal criteria he deems need to be satisfied might be typically reduced, in their broadest sense, to:

- Optimal growing conditions.
- Pleasurable play.
- Environmental integrity.
- Cost effectiveness.
- Good communications.

The diversified actions essential to the satisfaction of these criteria, when detailed, are many, the majority of which are most likely already being carried out. Those actions yet to be implemented, to fulfill the *whole*, stand out for attention. They earmark, too, the conditions and resources needed, either currently available or not yet in place, to be developed or acquired to carry out these actions.

Optimal growing conditions are nurtured by versatile irrigation, good drainage, adequate sunlight, unimpeded ventilation, balanced biological, chemical and physical soil properties, et al.

Pleasurable play is abetted when the course is set up fairly for all golfers, no matter their proficiency, minimal golf cart restrictions prevail, the course is well groomed, surroundings are picturesque, green speeds are consistent, et al.

Environmental integrity is satisfied by integrated pest management, water conservation, wildlife habitation, composting, community relationship, et al.

Cost effectiveness is derived from enhanced productivity due to high crew morale, safety and health considerations, machinery maintained functionally reliable, et al.

Good communications are going on with the club manager, golf professional, general manager, golfers and employees, meetings and social interactions, et al.

Holistic vs. Conventional Management

Conventional management derives from research. It is well intentioned, focuses on problems to be solved and can produce many remedies. However, solving problems without a broader understanding of how the problems arose will lead to competing goals, creating losses and successes at the same time. Holistic management encourages wider consideration of choices, giving equal weight to "new" and "old" approaches. Experience is valued as much as research. Trial and error also are a central part of the process. Skill and good judgment are not confused with rigidly directed management practices.

A holistic manager plans for flexibility; mistakes are detected early and the effects are softened with small adjustments before a crisis develops. He or she learns from the mistakes and successes of others, visits as many other operations as possible, asks questions, seeks answers, is open-minded, doesn't restrict imagination, attends seminars and field days, keeps good records, monitors progress, is patient, and most important, articulates an all-inclusive three-part holistic goal and keeps refining it with time.

Footnote

Holistic management, as a decision-making process, was initiated by Allan Savory, who emigrated to the United States about 20 years ago from Rhodesia, now Zimbabwe. The impetus for this application to golf courses derives from the introductiom of the holistic approach to students of natural resource management by Professor R. H. Richardson, Ph.D., at the University of Texas – Austin.

ARTHUR P. WEBER, *a semi-retired chemical and nuclear engineer, has been an active member of the USGA Green Section Committee since 1984. A longtime green committee chairman, he was the principal author behind the Old Westbury Golf and Country Club (NY)* Code of Environmental Conduct, *a leading set of principles for golf course maintenance.*

ENVIRONMENTAL COMMITMENT

Participation in the Audubon Cooperative Sanctuary Program can help superintendents make golf courses into environmental assets.

by PETER V. LEUZINGER, CGCS

Any decision made in managing the golf course impacts the environment.

GOLF COURSE superintendents began their careers for many reasons, one of which was environmental stewardship. We didn't call it that years ago, but we knew we liked working outdoors with Mother Nature. Along the way some troubling things happened to some of us. In the mid-'80s, groups of people began to accuse golf courses and the industry at large of being harmful to the environment. This perception was the complete opposite of how most superintendents viewed their work. We did not handle the criticism very well, and we hoped it would go away. This was not to be, as the criticism grew stronger in the early '90s.

Golf course superintendents who exerienced that period learned to deal with all kinds of problems, including criticism of our industry's environmental inadequacies. Environmental audits, conservation seminars, and the Audubon Program were the learning tools that helped develop new industry leaders. We learned to stand up for our environmental commitment. We had to lead by example. For me, involvement with the Audubon Cooperative Sanctuary Program for Golf Courses (ACSP) gave me the confidence I needed to look a critic in the eye and convince him or her that I was an ally of the environmental movement. Educated golf course superintendents from all over the country got actively involved with the ACSP and have found themselves in leadership positions in the commonwealth of environmental stewardship. Where we were once criticized, golf course superintendents are now depended upon to lend their expertise in land management and use for their communities.

To date, more than 2,300 golf courses across North America are participating in the Audubon Cooperative Sanctuary Program, and more than 110 golf courses are fully certified in the program. Golf course superintendents who are fully certified understand the basic fact that any management decision they make is going to impact the environment. We have been trained to understand the many benefits derived from this new decision-making process. These benefits include:

- Increased natural habitat and attraction of wildlife.

Taking a natural approach to bunker surrounds can reduce inputs and save money.

- Decreased chemical budgets and inventory.
- Decreased water use.
- Better pond and stream water quality.
- Increased property value.
- Improved employee training.
- Increased use of native plant material in landscaping.
- Reduced high-maintenance areas.
- Increased professional value to your course.
- Increased professional job satisfaction.

Once certification has been achieved, the next real challenge is maintaining that same degree of excitement and dedication to a follow-up program of recertification. I have found that maintaining environmental dedication requires some motivational discipline. I do it by focusing on the following objectives.

- Rereading my original environmental plan.
- Reviewing goals in each ACSP category of certification.
- Setting new goals and expanding projects.
- Promoting the program to golfers, peers, employees, and the public.
- Calling Audubon staff or your State Steward and sharing ideas.
- Recertifying every two years.

It is very important to periodically review the original goals that you set when you wrote your first environmental plan. Don't be afraid to re-evaluate those early objectives, because after a couple of years with the program, you will have learned a lot and will probably want to make changes for the better. I get excited about expanding programs. That is what keeps me going. Usually this involves getting people from various factions together to see what the golf course and the ACSP is all about. Every year we try to expand and/or modify the program. This expansion can do simple things like:

- Updating the club's Audubon brochure.
- Adding to or changing nest box locations.
- Writing an article for the local newspaper or soliciting a reporter to write a perspective on the course.
- Purchasing new and larger quantities of native plant material.
- Talking enthusiastically about the program to *anyone* with whom you come in contact.

What keeps our program alive and growing? I think it is our own enthusiasm sparked by feedback from the club members and community residents who have noticed the impact of the ACSP. People admire the changes that have taken place and now realize that this golf course is an asset to the community. To sum it all up, it's nice to get credit instead of criticism!

PETER LEUZINGER *has been a golf course superintendent for 23 years and is with St. Charles Country Club in St. Charles, Illinois. He has had two golf courses certified in the Audubon Cooperative Sanctuary Program, and he is a 1998 GCSAA Environmental Steward Award winner.*

New Construction Video Available

THE Green Section is pleased to announce the availability of a new video, *Building a USGA Green*. This 22-minute video provides an overview of the construction and renovation of a putting green from preparation of the site and initial grading to final seeding or sprigging. The discussion includes shaping, drainage, determining the need for an intermediate layer, and rootzone blending.

For nearly 40 years the USGA recommendations for putting green construction have been used for green construction around the world. When built and maintained properly, USGA greens have provided consistently good results for golf courses over a period of many years. This construction method represents the best insight and practical experiences of the Green Section staff and soil scientists from around the world.

The video is available through the USGA Order Department by calling 1-800-336-4446. The cost is $16.95 for USGA members and $19.95 for non-members, plus shipping and handling charges. The video is available in both VHS and PAL formats.

USGA Green Section Region Updates

ARE YOU looking for a way to keep up with the latest successes and problems of your neighboring golf courses? Look no further than the Green Section portion of the USGA website.

Throughout the year, the USGA Green Section agronomists will be writing regular updates for the website on the latest agronomic activities occurring in their regions. The topics will be as diverse as the golf courses visited by the agronomists, and will cover everything from acidic soils, algae, and armadillo damage to zinc deficiency, zoysiagrass, and zone irrigation control. Given the far-reaching places our agronomists visit, it's guaranteed there will be a few surprises included along the way.

You will find the USGA website at *http://www.usga.org*. The Green Section bullet will take you into all of the programs the Green Section is involved with. The regional updates are found under the Turf Advisory Service tab.

Visit regularly to find out what's happening within our world. You never know what kind of tips you might find.

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 S. Main Street
New Knoxville, OH 45871
Attn: Mark Flock
(419) 753-2448
(419) 753-2949 FAX

EUROPEAN TURFGRASS LABORATORIES LIMITED
3 Cunningham Road
Springkerse Industrial East
Stirling FK7 7SL Scotland
Attn: John Souter
(44) 1786-449195
(44) 1786-449688 FAX

N. W. HUMMEL & CO.
35 King Street, P.O. Box 606
Trumansburg, NY 14886
Attn: Norm Hummel
(607) 387-5694
(607) 387-9499 FAX

THOMAS TURF SERVICES, INC.
1501 FM 2818, Suite 302
College Station, TX 77840-5247
Attn: Bob Yzaguirre / Jim Thomas
(409) 764-2050
(409) 764-2152 FAX

TIFTON PHYSICAL SOIL TESTING LABORATORY, INC.
1412 Murray Avenue
Tifton, GA 31794
Attn: Powell Gaines
(912) 382-7292
(912) 382-7992 FAX

TURF DIAGNOSTICS AND DESIGN, INC.
310-A North Winchester Street
Olathe, KS 66062
Attn: Chuck Dixon
(913) 780-6725
(913) 780-6759 FAX

*Revised January 1998. Please contact the USGA Green Section (908-234-2300) for an updated list of accredited laboratories.

Never Stop Learning

But don't forget the basics.

by KEITH A. HAPP

Knowledge instills confidence and allows us to make informed decisions about new products and technologies.

IT HAS BEEN said that knowledge is power. For example, knowledge instills confidence to make decisions and to try new techniques. Knowledge also allows us to make informed decisions about new products. Some new techniques produce the desired results while simultaneously enhancing the efficiency and effectiveness of the efforts put forth to complete a task. On the other hand, many new techniques and ideas do not accomplish the intended goal. Implementing change, just for the sake of change, is not always the right course of action.

Countless journals and trade magazines bombard us with articles and features from all over the country touting new and better ways of accomplishing daily tasks. Researchers develop and evaluate theories, hoping to evolve these theories into tangible practices or procedures for everyday use. Everything starts with a question: "What if I did . . . ?" or "Could we try . . .?" or "How about if we incorporated . . . ?" The more questions that are asked, the more we learn. Unfortunately, the end user confronts the problem of wading through the new ideas to determine what will be most beneficial.

When considering any new idea, technique, or product, don't forget the basics. Without a sound basic foundation, how can any fine-tuning strategy be helpful? For example, when developing a fertilization program, try to determine the key limiting factor that hinders the utilization of the nutrients supplied. First, evaluate the environment. If the site is too shady, do what is necessary to enhance the light penetration. If the soil remains too wet, take a close look at the irrigation system. Is the water being applied uniformly? If the irrigation system is performing as desired, consider intensifying the aerification program so that the soil can be modified to better meet the needs of the turf. If modification is in order, attempt to achieve (via aeration or internal drainage) a balance of water, soil, and air to allow for sustained growth. Also, evaluate the natural air movement patterns and modify them if necessary. As airflow is enhanced, many of the previously described problems may disappear. As taught in many turfgrass management programs, two of the most important building blocks for strong turf come from the air: carbon and oxygen. Examining the conditions under which the turf is grown may seem like an oversimplification, but how many times are these basic components overlooked when problems arise? After all, sufficient quantities of air, water, and light are essential to all living organisms, and these foundational elements become increasingly important when outside stresses are imposed.

Another basic turfgrass management concept is mowing. It has been said that a bad mower can make even the best grass look and perform poorly. While planning the year's activities, examine the tools available to maintain the course. Are they adequate enough to meet the rigors of daily use and more than just functional? The mowers, after all, are critical components of the operation's infrastructure, and without a strong infrastructure many other problems can develop.

Finally, don't forget the people who make up the core of the team that prepares the surfaces for play. There are countless activities, conferences, and educational opportunities available for all of the key people who help make the operation a success. Assistant superintendents, golf course mechanics, irrigation specialists, and spray technicians can all gain valuable information when presented with the opportunity to attend state, regional, and national events. After they attend the meetings, take time to ask about their experiences. Simply asking if it was worthwhile, or if they would like to go again, may begin a dialogue that keeps the lines of communication open for some time to come. Concerns, needs, and problems may then be discussed more freely, and this can help the operation to run more smoothly.

Turf managers willingly share their experiences, good and bad, so that others may learn. This in itself makes the profession special. However, many times new concepts or processes are employed simply to keep up with the crowd. The full benefit of any advanced technology cannot be totally realized unless a strong foundation is in place. Keep the horse in front of the cart. You never stop learning; try new ideas, but don't forget the basics.

KEITH A. HAPP *is an agronomist in the Mid-Atlantic Region, visiting courses in the states of Delaware, Maryland, Pennsylvania, Virginia, and West Virginia. Keith joined the Green Section staff in 1993.*

Subscriptions $15 a year, Canada/Mexico $18 a year, and international $30 a year (air mail).

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

GREEN SECTION RECORD (ISSN 0041-5502) is published six times a year in January, March, May, July, September, and November by the UNITED STATES GOLF ASSOCIATION®, Golf House, Far Hills, NJ 07931. Postmaster: Address service requested — USGA Green Section Record, P.O. Box 708, Golf House, Far Hills, NJ 07931-0708.

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

Visit the USGA's Internet site on the World Wide Web. The address is:
http://www.usga.org

Turfgrass Information File (TGIF):
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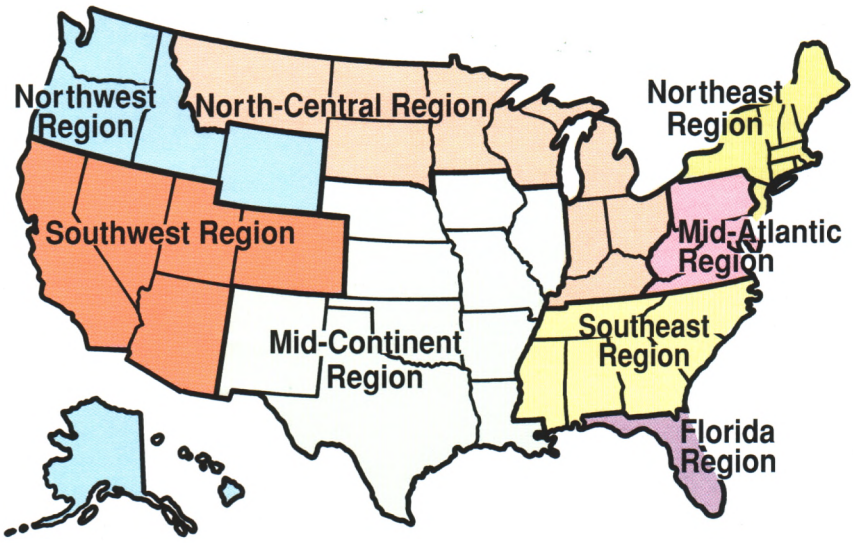

GREEN SECTION NATIONAL OFFICES:
United States Golf Association, Golf House
P.O. Box 708, Far Hills, NJ 07931 • (908) 234-2300 • Fax (908) 781-1736
James T. Snow, *National Director*
Kimberly S. Erusha, Ph.D., *Director of Education*

Research:
P.O. Box 2227, Stillwater, OK 74076 • (405) 743-3900 • Fax (405) 743-3910
Michael P. Kenna, Ph.D., *Director*

Construction Education Programs:
720 Wooded Crest, Waco, TX 76712 • (254) 776-0765 • Fax (254) 776-0227
James F. Moore, *Director*

REGIONAL OFFICES:

Northeast Region:
P.O. Box 4717, Easton, PA 18043 • (610) 515-1660 • Fax (610) 515-1663
David A. Oatis, *Director* • Matthew C. Nelson, *Agronomist*
1500 N. Main Street, Palmer, MA 01069 • (413) 283-2237 • Fax (413) 283-7741
James E. Skorulski, *Agronomist*

Mid-Atlantic Region:
P.O. Box 2105, West Chester, PA 19380-0086 • (610) 696-4747 • Fax (610) 696-4810
Stanley J. Zontek, *Director* • Keith A. Happ, *Agronomist* • Darin S. Bevard, *Agronomist*

Southeast Region:
P.O. Box 95, Griffin, GA 30224-0095 • (770) 229-8125 • Fax (770) 229-5974
Patrick M. O'Brien, *Director*
4770 Sandpiper Lane, Birmingham, AL 35244 • (205) 444-5079 • Fax (205) 444-9561
Christopher E. Hartwiger, *Agronomist*

Florida Region:
P.O. Box 1087, Hobe Sound, FL 33475-1087 • (561) 546-2620 • Fax (561) 546-4653
John H. Foy, *Director*

Mid-Continent Region:
P.O. Box 1130, Mahomet, IL 61853 • (217) 586-2490 • Fax (217) 586-2169
Paul H. Vermeulen, *Director*
4232 Arbor Lane, Carrollton, TX 75010 • (972) 492-3663 • Fax (972) 492-1350
Brian M. Maloy, *Agronomist*

North-Central Region:
P.O. Box 15249, Covington, KY 41015-0249 • (606) 356-3272 • Fax (606) 356-1847
Robert A. Brame, *Director*
P.O. Box 5069, Elm Grove, WI 53122 • (414) 797-8743 • Fax (414) 797-8838
Robert C. Vavrek, Jr., *Agronomist*

Northwest Region:
5610 Old Stump Drive N.W., Gig Harbor, WA 98332
(253) 858-2266 • Fax (253) 857-6698
Larry W. Gilhuly, *Director*

Southwest Region:
505 North Tustin Avenue, Suite 121, Santa Ana, CA 92705
(714) 542-5766 • Fax (714) 542-5777
Patrick J. Gross, *Director* • Michael T. Huck, *Agronomist*

TURF TWISTERS

DON'T COMPROMISE

Question: The Rules of Golf define the "teeing ground" as a rectangular area between designated markers and two club lengths in depth. How far apart should the markers be? (Ohio)

Answer: While available footage and play volume may force compromises, five paces between tee markers offers good course setup and reasonable wear distribution. Markers should be moved daily.

ATTENTION

Question: I have started a new job at an older golf course and am interested in determining the physical properties and drainage capabilities of the soils in the greens. What is the best approach to address these questions? (Connecticut)

Answer: That information can be obtained from a laboratory analysis of an undisturbed soil column. Collect an undisturbed sample using a 2" diameter PVC pipe. Pound the pipe down to a 12" depth to collect the sample (see: *Green Section Record*, September/October 1995). Seal both ends of the pipe with newspaper and duct tape in preparation for shipping to an accredited physical soil-testing laboratory. The laboratory analysis will provide a written record of the evaluation with information that will be useful for future management decisions. Contact a Green Section office in your region to obtain a list of accredited laboratories.

TO DETAILS

Question: Our golf course becomes a sea of styrofoam cups during the peak playing season. My manager feels that the maintenance staff is not being conscientious enough in regards to trash detail. How do other superintendents reduce the amount of trash blowing around their courses? (Texas)

Answer: Many courses have a *detail person* or someone whose job it is to pay attention to all the little things, such as trash. In addition, their job description would include filling the water jugs, emptying trash receptacles, filling the ball washers, moving ropes and stakes to guide traffic, and all the other detail-oriented chores. If the maintenance staff is too small to have a detail person, you might consider an interesting solution developed by a club in Texas. They cut ½-inch rings of 2½-inch PVC pipe and inserted them into the golf cart cup-holders. The tapered styrofoam cups fit snugly into the rings, thus reducing the overall number of styrofoam cups blowing across the course.