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Cover Photo:
Hole 4, Lower Course, Baltusrol Golf Club, Springfield, New Jersey, host of the 1993 U.S. Open.

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A water line break demands quick attention just before the championship begins.

Member-Guest or U.S. Open: How to Prepare for a Tournament

by TIM MORAGHAN
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THE U.S. Open and the mid-season Member-Guest Invitational may appear to be miles apart in importance and preparation, but a closer look reveals many similarities. Both events assemble prominent players to the arena for a short period of time, with specific demands of the contestant and high expectations from the host.

The superintendent's ability to plan in advance for changes in course architecture, agronomics, budgets, day-to-day operations, encounters with the contractors, and approaching deadlines all are tested during tournament preparation. Following are some of the standards applied to major championships that could be useful to know about as you prepare for tournaments, big or small, at your course.

ARCHITECTURAL CHANGES

Occasionally, changes in course design are included for U.S. Open preparation and are accomplished with the permission of the host club. Feature changes are usually minor, but a well-qualified golf course architect should be consulted. All features of the golf course are evaluated, and recommendations are made to improve conditions for the event and for the long-term benefit of the club. Following are typical changes to greens, tees, and fairways:

Putting Greens

- Recover lost green surface to restore strategic hole locations.
- Improve heavily trafficked hole-location areas by increasing surface area.
- Flatten or moderate a steep slope.

Installing new sand just prior to an event usually requires tamping or compacting activity to prevent fried-egg lies.

- Rebuild broken-down greenside bunker banks.
- Add drainage, remove trees, or completely rebuild or regrass the putting surfaces.

Teeing Grounds

- Reestablish a firm, level playing surface.
- Reshape and point the tee toward the architect's intended target.
- Add surface area, corresponding with the number of rounds played, to improve turf consistency.
- Reduce tree effects, by root or canopy pruning or tree removal, to improve turf performance or remove unfair obstacles from blocking tee shots.

Fairways

- Establish a fair but challenging target for all levels of ability.
- Fairway boundaries should provide shot variety from the tee and exact some degree of penalty for a poor shot.
- Place a premium on accuracy and allow the player to "let it out" with the driver on a long par-4 or par-5 hole.
- Establish specific turf types for fairways and roughs to avoid unwanted shrinking, straightening, or expanding.
- Properly established fairway perimeters will aid decisions on the position of extra features such as trees, bunkers, ponds, etc.

Grooming for a tournament combines two primary qualities: playing conditions and aesthetics. When referring to playing conditions, the thought that "green is not necessarily great" should apply to course conditioning. Over-irrigated and over-fertilized lush, green turf does not equate to or produce fine playing conditions.

The goal of preparing for a competition at any club should be to capture the "Golfer's Eye" — to have all areas of the golf course in proper playing condition, while meeting the need for extras such as an adequate supply of practice balls at each station and water in the ball washers on each tee.

GREENS

In preparing for a golf event, goals and priorities must be set. Statistics tell us that 42% of the game of golf occurs on the putting greens. Following are some factors to consider when grooming your greens.

- Greens should be firm and fast. Green speed should be established according to the skills of the contestants.
- Greens should provide a true putt and be uniform and consistent from green to green.
- Follow through with proper cultural practices.
- Maintain a preventative pest control program.
- Avoid excessive irrigation.

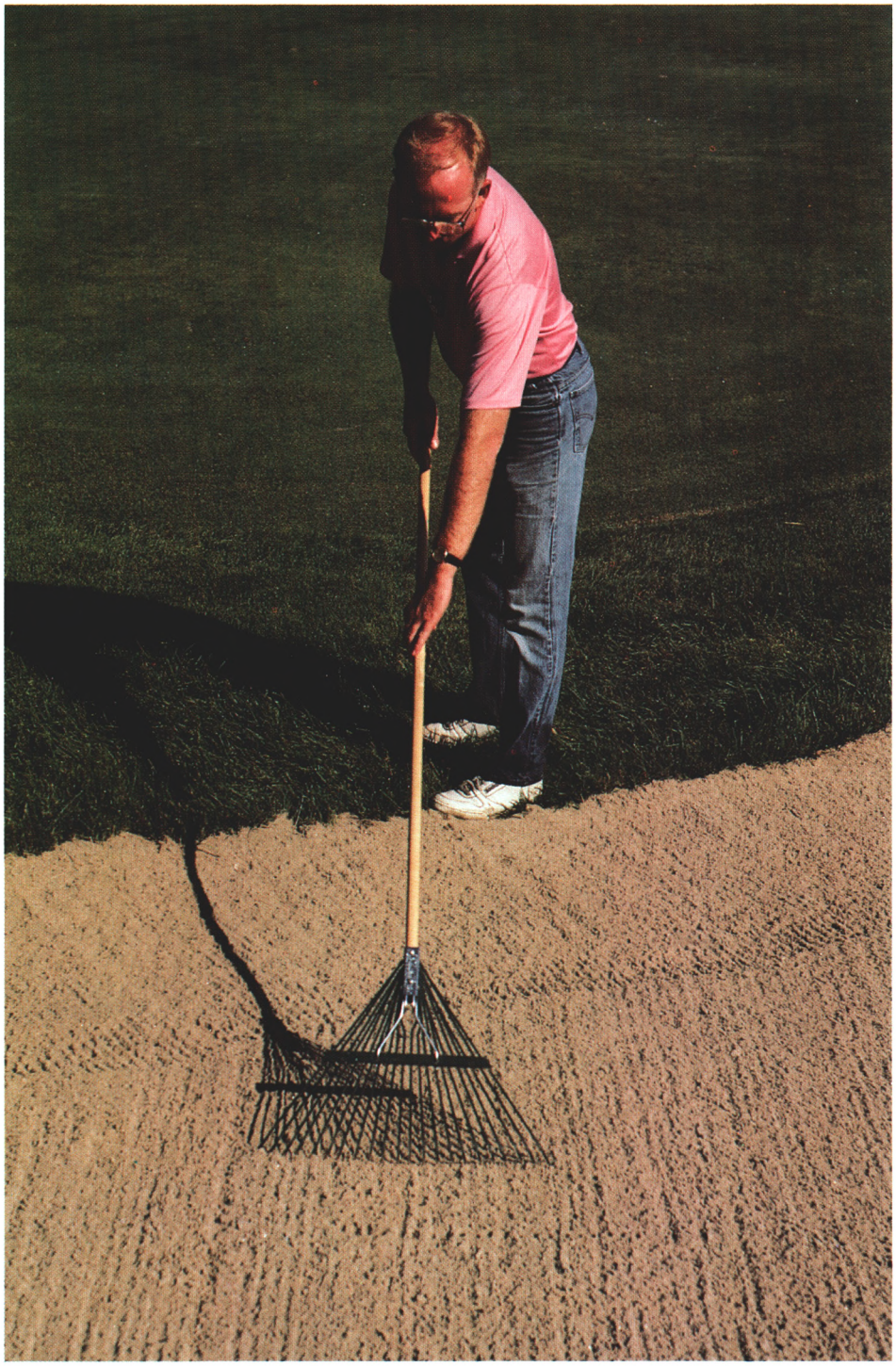
Aeration

Never a popular topic among golfers, the aeration process is a must to produce fine turfgrass that can withstand player and cul-

tural abuse during the week of a tournament. Following are some general guidelines.

- Aerification can be accomplished in mid-May, before the rush of play begins, and in mid-September, after all important club events have been played.
- Use half-inch hollow tines on conventional punch-type machines. Smaller tines have less impact on play.
- Remove the cores completely. Try to completely fill the holes with good-quality topdressing material.
- To avoid "pimpling," or the surge of growth near the top of the aerifier hole that causes a bumpy surface, continue topdressing lightly and frequently every two to three weeks.

Attention to detail is the name of the maintenance game in preparing for a tournament.



- Consider water injection as an alternate form of aerification.
- To minimize surface damage, consider using the quadra-tine aeration system.

Topdressing

Done to promote smooth, uniform, and consistent putting surfaces, topdressing on a light, frequent schedule is perhaps the most important management tool the golf course superintendent can use on established turf. The benefits for proper playing conditions include:

- A smooth putting surface, finer-textured turf, with a tighter, more upright growth.
- Control of unwanted grain or leafiness.
- Thatch and compaction control for better shot-holding characteristics.

For tournament preparation, applications should be just enough to be gently worked down into the upper profile of the green. A suggested amount would be ⅓ cubic yard of material per 3,000 square feet of putting surface. Topdressing should not be done closer than 14 days prior to the first day of your event.

Vertical Mowing, Turf Grooming, and Rolling

- Vertical mowing can be done to remove thatch and heavy growth. It often is done before aerification and before topdressing. New, sharp blades should be used during the spring and fall, while older, dulled blades should be used prior to the event to reduce turf stress. Heavy vertical mowing should be done at the optimum time for recovery.
- Turf groomers are used to produce smoother and faster greens without having to drastically reduce the cutting height. Grooming blades should be set about 1/32 inch below the cutting height, and best results are obtained when going in the opposite direction of the greensmower. Avoid grooming around the perimeter pass and on severely undulating surfaces. Grooming can be done as often as necessary, but caution should be used if signs of wear or turf stress are observed.
- Rolling units recently have been introduced to green maintenance programs. Initial use suggests that green speed can be significantly increased in some circumstances without having to lower the cutting height. Trials will be continued to determine the place of these machines in tournament preparation and green maintenance.

Traffic control is essential to protect the course when large galleries are expected.

Fertilization

Proper fertilization with respect to a tournament is based on application timing, amount applied, and type of fertilizer used.

- Reduce the amount of fertilizer applied as the event nears to minimize the opportunity for an unexpected surge in growth. Time the last application of granular products so that nutrient supply ends at about the time the tournament begins. Timing will depend on the type of fertilizer applied and the weather conditions expected at that time.
- Liquid applications of fertilizer can be used in combination with granular applications. With proper timing, liquid applications can maintain turf color and strength while avoiding unexpected growth. When using liquid products, add a dye for tracking to avoid overlapping or skips.

Irrigation

Applying too much water will make the golf course appear lush and green, but it will play soft and slow. Too little water may improve playing conditions, but the turf will be severely stressed. During the final month, manage your irrigation program day to day and apply water when and where it is required. The week preceding the tournament, and during the event itself, apply only enough water to keep the plant alive. Remember, it is easier to apply water to dry turf than it is to take it away from saturated turf.

- Always carry and use a soil probe.
- Understand the difference between hand-watering and syringing.
- Check all irrigation heads for water pattern and distribution.
- Level all irrigation heads in play areas.
- Check all syringe hoses and nozzles for leaks and have extras on hand.
- When syringing during play, work in reverse order when possible.
- Schedule sufficient manpower to cover all putting surfaces.
- Irrigate greens in the morning. Watch the water pattern and look for leaks, breaks, sticking heads, and signs of overwatering.

TEEING GROUNDS

The teeing ground is the starting place for the hole to be played. Tees should be level, firm under foot, and closely cut. Proper cultural practices are required to insure healthy turf to withstand player use.

- Divot repair should take place on a daily schedule and be done at the end of each round.
- To protect the play areas prior to the event, use wind screen or erosion netting. It can be laid down or placed upright by using stakes.
- Mow tees in the morning to provide a fresh cut, remove dew, check for damage, and reduce the afternoon workload.
- Prune surrounding trees to eliminate unnecessary interference and improve turf growth.
- Prepare at least two complete sets of tee markers that are the same shape and color.
- A note on location: It is preferable that tee markers be placed about six yards apart. If the width of a teeing ground is wider than that, players are more likely to inadvertently tee up in front of the tee markers. Tee markers should be set up square with the center of the drive zone.
- Place a small white dot of paint on the turf beneath the marker to preserve the location and position of the teeing ground in the event a marker is lost, stolen, or broken during play.
- If caddies are involved, place a five-gallon bucket filled with water near the tee so they can wet their towels to clean clubs and golf balls during play.
- Place all accessories (benches, ball washers, trash cans) within reach, but away from the designated tee.

- The teeing area is usually rectangular in shape, measures 5 to 10 yards in width, and is two club lengths in depth.

FAIRWAYS

A course should be set up to require accuracy as well as length. For the U.S. Open, fairway widths range from 27 to 35 yards. On a short par-4, a 27- to 30-yard fairway is adequate, but on a long par-4 the fairway should be wider to allow players to "let it out." The narrowing or widening of fairways, which necessitates a change in mowing height, should be undertaken as long in advance of the competition as possible. Fairways should be maintained to provide a firm and tight turf. Fluffiness results in "fliers," or shots without much backspin.

- To decrease grain and playing against a mowing stripe, mow fairways at an angle against the directon of play.
- Locate the center of the landing zone from the tee, and repair all unplayable areas from that point going 45 yards forward to the green and 45 yards back toward the tee.
- Overwatering landing areas and approaches to greens will be perceived as tricking up the course.
- When mowing, use metal irrigation flags as directional markers for straight lines.
- Dew drag before mowing with a hose filled with water or sand to reduce bouncing and decrease the formation of clipping piles.
- When using two lightweight mowers, start mowing in the middle of the fairway landing zone and work in the opposite direction. This avoids extra tracking, turning, and clipping piles in the drive zone.
- Mow fairways as you would paint a floor. Start near the first tee and mow away from play to keep noise and interference away from the competition.
- For clipping removal, park a truck in a centrally located position to reduce the travel time of the mowers, and provide a supply of soil and seed so the driver can patch divots until the truck is full of clippings and ready to be driven to the disposal area.

BUNKERS

The settled depth of sand in bunkers should be 4 to 6 inches, except that the sand in the faces of bunkers must be shallow and firm enough to prevent balls from becoming plugged or lost. To prevent this, create a lip on the front edge of greenside bunkers. No new sand should be placed in the bunkers within eight weeks of the first day of practice.

- To settle new sand, apply a wetting agent at 6 to 8 ounces per 1,000 square feet every 7 to 10 days.
- For packing sand, use the mechanical sand rake with its rakes raised and drive back and forth over the floor of the bunker. Using a hand-held hose, irrigate the sand prior to packing with the sand rake or other packing device.
- To aid in the firming process, hand rake bunkers when labor and time permit. When hand raking, always rake in the direction of the shot be be played.
- Use backpack blowers to quickly remove leaves, twigs, and debris after strong winds or a storm.

ROUGHS

Roughs should be of sufficient height to provide a significant problem, but not so penal that a player in the rough off the tee will have to take a wedge and hack the ball sideways to the fairway. If the rough is this penal, a player will be penalized a full stroke for an errant drive. The USGA believes that the penalty for straying off the fairway should be about one-half stroke.

- For a cleaner cut and more upright stand of turf, use a rotary mower as opposed to a reel mower.
- To reduce the competition for water and nutrients, and to improve the density of the rough, root prune along all tree-lined roughs.
- For a thick stand of turf, consider a dormant fertilization with an organic source such as Milorganite in the late fall. In the spring, use a soluble product when the event nears.
- To keep the rough growing upright, remove all vehicular traffic from the roughs 14 days prior to the first day of the event.

EQUIPMENT INVENTORY

Each piece of equipment, from shovels to lightweight fairway mowers, should be accounted for during the off-season, prior to your club's budgetary review and the upcoming event.

Inconsistencies in the rough may require major renovation in some cases.

- Your event may require a separate tournament budget.
- Review your equipment and decide if you have what it takes to get the job done and done on time. If not, then present the dilemma to the Board for evaluation.
- If there is a shortage in one area, especially heavy equipment, consider a lend/lease program with local distributors or neighboring clubs.
- Even the best equipment inventory can be lacking during an emergency. Know who, where, and how to acquire additional equipment in times of crisis, including bad weather, vandalism, and parts shortage.

Consider the following items and their value to your event, and plan for their use and/or shortage.

Marking Stakes

Have an adequate supply of marking stakes, including those for out-of-bounds (OB), ground under repair, water, and lateral water hazard. OB stakes should be placed no more than 20 yards apart so the player or official will have line of sight from stake to stake when making a ruling. Hazard stakes should be 2" × 1" × 24" in shape, and OB stakes should be 2" × 1" × 36".

Flags and Flagsticks

The USGA supplies two sets of flags to the host club for USGA championships. Having two sets of flags helps in case of damage, vandalism, and souvenir hunters. The USGA requires flagsticks be supplied that are 8 feet in length, yellow for sighting against a gallery, and straight from top to bottom in design. As with the flags, have two sets of flagsticks on hand.

Pumps, Hoses, Squeegees

When it rains during an event, it pours, usually uncontrollably. The goal after a rain delay is to return the course to the competitors within 45 minutes after the rain has stopped. To make the transition easier, consider the following:

- Divide the course into sections (three or four) and have two pumps per section.
- One hundred feet of hose should accompany each pump to move water far enough away so it will not return to the area just cleared.
- Each section should have at least five squeegees, shovels, and rakes to move water, replace sand, and clean up debris.
- For easy transport, have one utility vehicle per section.
- Clean and flush all known drain lines for bunkers, greens and fairways to remove blockages that would slow down the recovery process.

Ball Washers, Towels, Benches, Water Coolers

Each item is required for any event. Whether or not they are used depends on the contestant. They should be placed for easy use, but not so close that they would interfere with play.

- Water cooler placement depends on terrain, temperature, and size of the field. Normally, one cooler per tee is sufficient. However, the warmer the weather, the more water is consumed, so be prepared to have 36 coolers for the golf course, and an additional 12 for replacements.
- Tee towels should be thick enough for cleaning. Avoid fancy logos that would make attractive souvenirs.

Plywood Sheets

Wet weather, soft ground conditions and heavy equipment can make a great impression, but on the negative side. Erecting tents, scoreboards, and concession stands requires traffic of heavy equipment across the golf course. Having 50 to 100 sheets of 4' × 8' ¾" plywood on hand make it much easier to traverse the course.

Sand, Soil, and Woodchips

Bad weather or excessive vehicular and spectator traffic can cause very muddy conditions both on and off the golf course. Arrangements should be made to provide an ample supply of woodchips, bark, mulch, sand, or similar material available for such conditions. Also, make arrangements with your supplier for quick delivery and easy access to the club.

Radios

Proper communication is essential for a smooth-running operation. Radio contact between the superintendent, crew, clubhouse, and tournament officials is a must, especially during an emergency. For quick and easy response, acquire a multi-channeled radio, where each area of responsibility for the event can conduct its business on its own station.

SPECIAL CONSIDERATIONS

Weather Emergencies

Foul weather, heavy rains, and lightning are quick to form and can be very dangerous. Thorough preparation and evacuation plans for sudden storms should be complete and practiced.

- Develop a written plan for everyone involved covering emergency procedures and evacuation.
- Contact and work with local weather authorities.
- Have buses, vans, and cars positioned at specific spots for evacuation.
- Provide a course map with the position of vehicles and rain shelters.
- If the fairways are lined with private homes, check with the owners for permission to house golfers during a sudden storm.
- Have a warning system (sirens, horns, etc.) loud enough to be heard on all parts of the course.
- Contact local police, fire, and EMS groups, and coordinate their services for the event.

Security and Medical

For protection and first aid it is suggested that these services be contracted out. The professionalism and experience cannot be substituted.

- Course security is most important at night.
- Provide a tour of the course for security staff and set aside two working golf carts for each night.
- Medical personnel should be centrally located on the course.
- A quick, easy, and firm roadway should be provided for easy entry and exit.

Parking

Though you may not have U.S. Open numbers with respect to parking demands, it would be wise to have an area large enough to meet your needs.

- Priority should prevail for your members, clubhouse staff, and grounds maintenance personnel.
- All parking areas should be well drained, dry, and easy to get to.
- Always have backup parking available.
- Contact a towing service for repairs and for cars that are stuck or abandoned.

Preparing a course for a tournament, whether it be the U.S. Open or the annual member-guest, can be stressful for all involved. Good communications can keep problems and conflicts to a minimum. But keep in mind that golf is a game. Take some time to enjoy the event, watch some golf, and take pride in the fruits of your labor.

Sprinkler Head Testing Makes Dollars and Sense

by DR. KENNETH H. SOLOMON, PE
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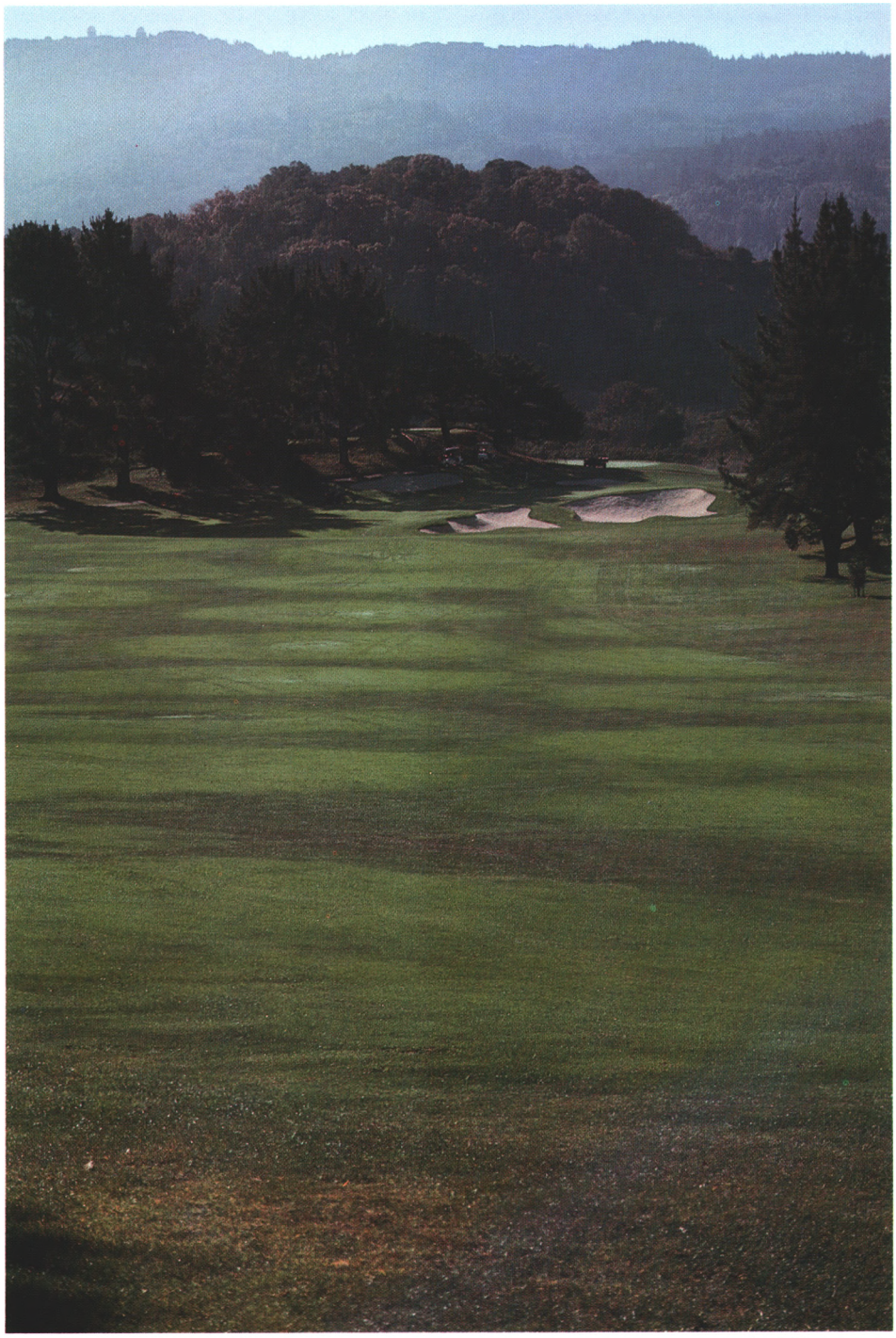
IN THE SOUTHWEST, where Mother Nature provides very little natural rainfall, uniform irrigation coverage is vital to maintaining both the health of the turf and the beauty of the course. Even in regions that receive more rainfall, where irrigation is only supplemental, uniform coverage should not be taken for granted, for it is nonetheless very important.

In addition to health and beauty, or what golfers directly see, golf course irrigation also represents a significant portion of the annual maintenance budget. More specifically, this cost includes capital improvement and/or system replacement, ongoing repair and maintenance, and water and energy usage. No matter what the specific costs, proper sprinkler head testing can be used to insure that every dollar will be spent wisely.

For new golf courses, sprinkler head testing can be used to select sprinkler head models and spacing combinations that produce optimum, uniform coverage. For existing irrigation systems, sprinkler head testing can be used to troubleshoot problems, identify deficiencies, and indicate the best means to make future capital improvements. To illustrate, this article will review what sprinkler head testing and analysis involve, discuss a measure of sprinkler head performance developed especially for turfgrass irrigation, termed Scheduling Coefficient, and consider the economics of improving the coverage of both new and existing irrigation systems.



Many golf courses are plagued by poor irrigation coverage by failing to take into account proper spacing of sprinkler heads. Sometimes these circumstances can be improved by testing alternative nozzle types and/or operating pressures.

Sprinkler Head Testing

During a test, the amount of water that falls at various distances from the sprinkler head (application rate) is measured with equally spaced containers. The resulting data then can be used to develop a "profile" that is representative of a particular sprinkler head model, nozzle combination, and operating pressure. Using special computer software called SPACE (Sprinkler Pattern And Coverage Evaluation), each individual profile can be "rotated" to simulate circular sprinkler head patterns, and then "overlapped" to simulate the irrigation

coverage of multiple sprinkler heads positioned as they would be on the golf course.

Uniformity Measures

Unfortunately, no irrigation system, or even Mother Nature, applies water in a "perfectly" uniform manner, so there will always be a number of both wet and dry spots. The mainstream agricultural industry has long used a calculated Coefficient of Uniformity (CU) to measure such non-uniformity in water application for a given sprinkler head, nozzle type, operating pressure, and spacing combination. Turf irrigation professionals generally agree, however, that the interpretation of CU for turfgrass irrigation is difficult at best, and often misleading. A high CU, for instance, is no guarantee that dry spots will not develop on the golf course. To deal with these circumstances, the Center for Irrigation Technology (CIT), in Fresno, California, has developed another measure of uniformity called Scheduling Coefficient. Except in cases when a golf course has extremely poor drainage, underwatering of specific areas is the most significant problem. The Scheduling Coefficient, therefore, looks at the water application rate of the critical dry areas and compares it to the average water application rate over the entire golf course.

For example, suppose the average water application rate from the sprinkler system is 0.5 inch per hour. If the turfgrass needs 2 inches of water per week, then each sprinkler needs to run four hours per week to meet those needs. In the critical dry areas, the actual application rate is less, say only 0.25 inch per hour. If the sprinkler heads are run four hours per week, then this area will receive only one inch of water, or half the amount of water required by the turf-grass. As one would expect, the critical dry areas are the first to discolor and then deteriorate from lack of water.

To compensate, the golf course irrigator is forced to program longer irrigation cycles. In order to apply the needed 2 inches per week in the critical dry areas, the irrigator will have to run the sprinkler heads eight hours per week, or twice as long as the irrigation cycles needed for the rest of the golf course.

The Scheduling Coefficient is, more precisely, a run time multiplier, and is calculated by dividing the water application rate in the critical dry areas into the average water application rate. The Scheduling Coefficient for our example, then, is $0.5 \div 0.25 = 2.0$.

Scheduling Coefficients are, by definition, greater than 1.0 and ideally below 1.5. Good irrigation systems have Scheduling Coefficients of approximately 1.1. Unfortunately, many golf courses are currently being irrigated by systems with Scheduling Coefficients that measure as high as 2.2 or more!

TABLE 1

Sprinkler Spacing and Coverage Analysis

Actual Test Results for Three Golf Course Sprinklers

Sprinkler*	Equilateral Triangular Spacing % of Diameter	Coefficient of Uniformity	Scheduling Coefficient
Brand A	50	92	1.77
	60	72	2.15
	70	62	2.05
Brand B	50	89	1.40
	60	73	2.11
	70	71	1.77
Brand C	50	84	1.35
	60	83	1.65
	70	84	1.32

*All three sprinklers deliver approximately 27 gallons per minute at a pressure of 70 PSI, and have a 74-foot radius of throw.

Improved Efficiencies Save Money

Local utility rates and the golf course size, in terms of acres under irrigation, dictate the water and energy costs for each course. In the arid Southwest, annual water and energy costs may amount to $1,500 per acre. For a large course, the total bill can easily be $150,000 to $250,000 per year. Even in areas where less irrigation is required, the cost for water and energy can be substantial.

Consider the case of a course spending $100,000 per year on water and energy. By testing the sprinkler heads, operating pressure, and spacing combination, it is determined that the Scheduling Coefficient is 2.1. Although not unusual, 2.1 is not very good, to say the least. If the course could adjust its irrigation system to achieve a Scheduling Coefficient of 1.3, the water and energy bills could be reduced to $61,900 [$(1.3 \div 2.1) \times \$100{,}000 = \$61{,}900$], or a savings of over $38,000 per year. If the Scheduling Coefficient could be reduced to 1.1, the water and energy bills could be cut nearly in half. Recognizing that these are annual figures, the long-term savings could be very substantial.

Under these circumstances, the course could afford to spend $70,000 on capital improvements of the irrigation system, and the investment would be paid back in less than two years. Indeed, investing in a lower Scheduling Coefficient can be a wise investment.

Next, consider the case of a course planning to install a new irrigation system. The irrigation designer commissioned to engineer a new system has a choice of many sprinkler head makes, models, and spacing combinations. Testing the sprinkler heads in advance can provide guidance as to the best design choice.

For example, consider the sprinkler head test data in Table 1. These results are from tests run at CIT on three actual golf course sprinkler heads. All three sprinkler heads have the same flow rate and distance of throw. In fact, if you looked them up in the manufacturer's catalogs, you might conclude that these sprinklers are "equal" and could be substituted for one another.

After further examination, however, the Scheduling Coefficients for these three sprinklers are NOT the same. Even when spaced to throw "head-to-head" (spacing equals 50% of the wetted diameter, these sprinkler heads' Scheduling Coefficients range from 1.32 to 2.15. Furthermore, note that the sprinkler head with the best Coefficient of Uniformity is not the one with the lowest Scheduling Coefficient.

Even with head-to-head coverage, these similar sprinkler heads do not have the same

(Top) Through proper testing of existing irrigation systems, their performance can, in many cases, be significantly improved. By doing so, the course not only looks better, but water and energy bills are also reduced.

(Above) For those golf courses with poor irrigation coverage, the irrigator is forced to program long irrigation cycles to compensate for critical dry areas. To the golfers' disappointment, wet areas then develop.

performance or Scheduling Coefficients. As in the case of improving existing irrigation systems, the difference between 1.32 and 2.15 can mean thousands of dollars per year in future water and energy costs. Buyer beware; it's much better to test the sprinkler head and make the right choice before the system goes in the ground.

Testing sprinkler heads and analyzing the results can be of great benefit, either for new or existing golf course irrigation systems. Sprinkler head testing can guide selection or renovation decisions, resulting in higher irrigation efficiencies and lower Scheduling Coefficients. Such guidance also can lead to large savings in the form of reduced water and energy bills.

To contact the Center for Irrigation Technology for more information, readers can call (209) 278-2066, or write to: Center for Irrigation Technology, 5370 North Chestnut Avenue, Fresno, CA 93711-0018.

A USGA-SPONSORED RESEARCH PROJECT

Out of Africa — A New Look at "African" Bermudagrass

by DR. CHARLES M. TALIAFERRO
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SOME AFRICAN bermudagrasses now under study at Oklahoma State University offer new possibilities as improved varieties and for use in breeding, but bermudagrasses from Africa are not new. In fact, the African continent is generally considered as the center of diversity for bermudagrass and, consequently, its most likely place of origin. The first bermudas introduced to the New World probably came from Africa in the early to mid-1700s. Most past and present turf bermudagrass varieties used in the U.S. trace to Africa either as direct imports or through ancestry.

As a common name, "bermudagrass" generally refers to forms of *Cynodon dactylon*, which together with *C. transvaalensis* constitute the two most important *Cynodon* species used for turf. *C. transvaalensis* plants have been given the common name "African bermudagrasses." These very fine-textured plants have crossed naturally and have been artificially crossed with bermudagrass plants to produce fine-textured, high-quality turf hybrids. As examples, "Sunturf" (Magennis) and "Bayshore" are considered natural hybrids between African and common bermudagrasses. The widely used "Tifway" (419) and "Tifgreen" (328) varieties developed by Dr. Glenn Burton at Tifton, Georgia, had an African bermudagrass as one of their parents.

Although African bermudagrass has played a very important role in the development of many of the improved turf bermudagrass varieties, until recently there has not been a concerted effort to assess the improvement potential within the species. Thanks to USGA financial support, such an effort is now underway at Oklahoma State University. This effort is part of a comprehensive USGA-sponsored research project to breed improved seed- and vegetatively-propagated bermudagrass varieties for different environments and uses.

African bermudagrass differs in several respects from the usual type of bermudagrass grown as turf throughout the southern U.S. Its natural distribution is limited to a relatively small geographic area within South Africa consisting of the Transvaal and

Unmowed African bermudagrass, in a breeding plot at Oklahoma State University, is allowed to produce seed heads (inflorescences) which are used to produce crossed and open-pollinated progenies.

Of 100 African bermudagrass plants in the screening nursery at the High Ridge Country Club, Lantana, Florida, only a few survived and continued to perform well after one year. John Foy, USGA agronomist (left) and David Bailey, former superintendent, examine a plant that had performed well.

Orange Free State, whereas the more common form of bermudagrass is widely distributed throughout tropical and semi-tropical regions of the world. Even in its natural habitat, African bermudagrass is more sparsely distributed than other bermudagrasses, generally inhabiting damp sites. It has fine, linear, pale yellow leaves, small stems, and profuse shallow rhizomes, which contribute to its very fine texture and greater sod density compared to other bermudagrasses. It exists only as a diploid with 2n=2x=18 chromosomes. Other turf bermudagrasses generally are tetraploids with 2n=4x=36 chromosomes, although diploid and triploid (2n=3x=27) types occur naturally.

Only a few African bermudagrasses have been introduced into the U.S. Currently, 15 *C. transvaalensis* accessions are listed in the United States *Cynodon* germplasm collection at the Southern Regional Plant Introduction Station, Griffin, Georgia. A few have been lost from the collection over the years, and it is possible that a few others entered the U.S. without being included in the collection. A small number of African bermudagrasses were introduced into the U.S. during the first half of this century, primarily by the New Crops Research Branch, Crops Research Division, USDA/ARS. Some of these, such as PI (Plant Introduction) 213319 ("Florida) and PI 183551 ("Uganda") had limited use as turfgrasses in the southern U.S. before being supplanted by better-performing hybrid varieties. Major criticisms of the few African bermudagrasses tried as turf included one or more of the following: 1) high demand for water and nutrients, 2) propensity to thatch, 3) yellow-green color, 4) development of purple pigmentation in response to cool temperatures, and 5) overall decline in quality during late summer and fall. Their major assets, however, are a very fine texture and the ability to form a dense sod under good growing conditions. An important question, then, regarding the overall value of African bermudagrasses, relates to whether the deficiencies of the few varieties tried in past years are common to the species as a whole. Work is now underway to help answer this question.

In the summer of 1988, some of the African bermudagrass accessions in our germplasm nursery were found to have excellent fertility, ranging from 72% to 83% of florets producing a seed. These have provided large progeny populations for breeding and genetic study. Using open-pollinated seed harvested from the fertile plants in late June 1988, 816 progeny plants were started in the greenhouse and transplanted to a field nursery on August 1, a late planting date for Stillwater, Oklahoma. By the end of the growing season, differences were evident among these plants in rate of spread, growth habit, and other characteristics. Dramatic winter hardiness differences among the plants were revealed in the spring of 1989. Responses ranged from complete winterkill to early vigorous greenup. Selected plants from this nursery were included with their parents in isolated field crossing blocks to produce intermating populations. Since 1988, over 6,000 progeny have been grown as spaced plants in preliminary breeding evaluation nurseries.

A step-wise plan was effected in 1990 to screen large numbers of these progeny under different environments and uses and then intensively evaluate a small number

Differences in fall color retention and appearance of African bermudagrasses are being investigated by graduate student David Gerken at the Turf Research Center, Stillwater, Oklahoma.

(15-30) of the very best selections. In early June 1990, 3,300 progeny from the breeding nurseries were planted at the Stillwater Turf Research Center on 3-foot centers in nursery blocks mowed at putting green heights. In October 1990, 400 selected plants from these blocks were transplanted, in groups of 100, on each of four cooperating Florida golf courses. The cooperating courses were Country Club of Orlando, in Orlando; Fiddlesticks Country Club, in Ft. Myers; High Ridge Golf Club, in Lantana; and Palm Beach Country Club, in Palm Beach. An additional 189 selected plants were planted in early spring 1991 on the Sea Island Golf Club, Sea Island, Georgia. These plantings were designed to screen the 589 plants for adaptation and overall performance under the same management programs that the golf courses use for their putting greens. Performance criteria of special interest were maintenance of a uniform, dense sod under close mowing, quality of the putting surface, and consistency of performance across seasons, particularly plant response to high summer temperatures and low winter temperatures.

It was expected that one to three years would be required for the "sorting out" process to occur and for any truly superior plants to be identifiable. Experience has shown that many bermudagrasses may perform very well for one to three years after establishment, then quickly deteriorate in stand and quality. Truly superior golf course turf is best identified by thorough testing over several years under conditions that subject it to the various stresses imposed by actual golf course use. As in the Stillwater nurseries, substantial differences were noted among plants in rate of spread, texture, sod density, and color during the establishment phase. There also were differences among the Florida locations in overall rate of establishment, due primarily to imposed management. Two locations overseeded soon after planting in 1990 while two did not. Mowing heights at the different locations also were lowered at different rates during the establishment period.

By October 1991, one year after planting, the sorting process was progressing rapidly at some locations. At the High Ridge Country Club in Lantana, about half the plants had perished, and most of the others were obviously inferior. A few plants, however, were maintaining very high quality turf. Three of the 100 original plants were identified as having superior performance. At Palm Beach Country Club, all plants had survived, but there were substantial differences in texture, sod density, color, and overall turf quality. Five plants were identified as having superior performance. Four additional plants were selected from the Palm Beach site in February 1992, based on good color retention during the winter months. Only two plants at the Ft. Myers location were judged worthy of further evaluation. Stand establishment at the Orlando site was delayed by overseeding and no substantive differences were noted among plants in 1991. Changes in persistence and performance of plants at the different locations is expected to continue, and they will be closely monitored over the coming months. The results to date suggest, however, that this procedure is effective as a preliminary screen for desirable plants. Screening of even larger numbers of African bermuda progeny plants will be initiated in spring 1992.

In the spring of 1991, graduate student David Gerken began an intensive replicated experiment designed to test the putting green performance of six African bermudagrass selections in comparison to Tifgreen and Uganda. Plots 10 × 12 feet in size, replicated four times, were planted in April 1991 at the OSU Turfgrass Research Center. Each individual grass plot is subdivided into halves which are mowed at heights of either ⅛ or 3/16 inch. David collected data on rate of establishment, sod density, color, putting speed (Stimpmeter), yield of clippings, and overall turf quality. Although there were differences in rate of spread, all plots were fully covered by the end of August. First-year data supported previous observations and results indicating the existence of substantial variation among African bermudagrass progeny. Significant differences among strains were found for all response variables. Some of the African selections performed better than both Tifgreen and Uganda for overall turf quality, sod density, and putting speed. Tifgreen received the highest rating for color. The most impressive of the six African selections, however, maintained a dense, uniform turf only slightly lighter in color than Tifgreen.

While more testing is necessary to accurately characterize the performance of the African bermudagrasses now in trials, results to date are promising. If the performance of the elite plants selected in 1991-92 is maintained in intensive tests over the next three years, one or more could then be released as new varieties.

Cumulative results with African bermudagrasses indicate substantial variation within the species for the major traits affecting turf performance. The extent to which the observed variation is heritable will dictate its value in breeding for improved turf performance. Genetic studies are planned that will provide information on the magnitudes of heritable variation for important turf traits within the species.

African bermudagrass selections should be of value in the breeding of new triploid hybrid turf bermudagrasses by serving as elite parents in crosses with common bermudagrasses. African plants now being identified as having superior turf performance can be tested as parents in such crosses to determine their genetic value in producing superior progeny. A wealth of valuable turfgrass germplasm has come out of Africa, and this work with African bermudagrasses suggests that the supply is far from exhausted.

A Practical Guide to Analyzing the Soil Profile of Golf Greens

by TOM MASCARO
Green Section Committeeman

ESTABLISHED GREENS can reveal their secrets when you analyze the soil profile. Golf greens contain a world of information. The complete life cycle of new or old greens can be easily analyzed by taking a close look at their profiles. With this information, the turf manager can develop a management program that can prevent, or at least minimize, future turfgrass problems. Monitoring the soil profile of greens also helps to establish a record of existing conditions and reveals the progress of the management program. A soil profile can reveal a number of problems which could eventually affect the health and growth of turfgrasses.

The soil profile can be compared to the rings of a tree. Growth rings reveal the secrets of a tree's growth, and just as they tell us its age by counting the number of rings, they also tell us something about the climate and growing conditions by the space between rings. The soil profile also can reveal its secrets if observed properly. An undisturbed soil profile can reveal its origin and gives clues as to whether it is natural or man-made. If man-made, it reveals how well the soil was mixed during construction. A soil analysis can be carried out by allowing the sample to dry and then passing it through sieves to separate it into its components of sand, silt, and clay.

There are numerous ways of exposing an undisturbed soil profile. One way is with an ordinary shovel. Digging away the soil and leaving a clean vertical wall exposes its profile for observation. Another method involves the use of a specially designed tool which extracts a clean soil sample without disturbing the playing surface.

A clean soil profile, to a trained eye, can be read like a book. Close observation can reveal both good and bad conditions that may exist in the top 6-inch layer of soil.

Care should be exercised when taking soil samples so that the profile remains intact and in its undisturbed state. When studying a soil sample, observe everything. Many times, more than one problem can be revealed. Start at the top of the profile and check each of the following characteristics in this list.

Turfgrass Leaves — Observe the green surface leaves. Use a magnifying glass to observe the cut of the grass blade. A clean cut is necessary for proper appearance, health, and playability of the plant. A torn, ragged cut indicates that adjustments need to be made to the greensmowers. Severely injured leaf tissue exposes more plant cells to infection from disease organisms. A ragged cut also causes an unsightly brown appearance in the turf. Look for disease spots or lesions on the leaf. Also, check for injury from leaf-sucking insects.

Topdressing — Observe the topdressing and how it is intermixed with the thatch. If recent topdressings have not made contact with the soil below the mat, there is a strong possibility that a layer is beginning to form. Make sure the buildup of topdressing is following the growth rate of the turf.

Thatch — Next, measure the depth of the thatch layer. Generally, the deeper the

A soil profile tells the story of how a topdressing program has changed the profile over time. A consistent sand topdressing program has built a good rootzone over heavy clay soil.

thatch, the more it affects the general health of the grass plant. The depth of the thatch on a green should form a cushion of no more than about ¼ inch. A heavy thatch layer can affect a green in many ways. It can harbor diseases and destructive insects, and can impede the movement of water into the soil. It acts as a filter, keeping nutrients and pesticide from entering the soil. The depth of the thatch layer can have a pronounced effect upon the depth of the root system.

Mat — Mat layers form beneath, and are intermixed with, the thatch layer. This layer is mostly decomposing thatch, and will usually be dark brown or black in color. A heavy mat layer resting on the soil surface can create an impervious barrier when allowed to dry. When wet, it can seal off the free flow of oxygen into the root zone. It also can contribute to anaerobic conditions.

Fungi — Beneficial fungal activity sometimes can be observed in the mat layer. The white or brown mycelia (threads) of these beneficial organisms are in the process of breaking down organic matter which can be recycled as food for the grass plant. When conditions are favorable, disease spores also can germinate and grow rapidly in the mat medium.

Insects — Chinch bugs and other leaf-sucking insects sometimes can be found in the thatch and mat layers of a soil profile. These layers provide an almost perfect environment for insect feeding and reproduction.

Grubs, Mole Crickets — Look for grubs and cutworm activity. Mole crickets also can be found in the thatch layer in southern turf. If present, sample other areas to determine if control measures should be taken.

Algae, Black Layer, Slim Mold — Algae, black layer, and slime molds often can be observed growing in the mat layer, on the soil surface, and in the soil profile. Their growth usually is encouraged by soil acidity and excess soil moisture. These problems can be controlled by raising the pH with lime, and by aerifying and reducing water use.

Undissolved Nutrients — Undissolved nutrients sometimes can be found trapped in the thatch and mat layers, which act as a filter that can slow down or stop the downward movement of slow-release materials such as lime, potash, and other nutrients. Aerification and removal of excess thatch are important objectives of every turf management program.

Soil Texture — Next, study the texture of the soil in the profile. This can be accomplished mechanically, with sieves, or visually. Make a rough estimate of the percentage of sand, silt, and clay, and record this information. A small microscope placed right on the sample will magnify the different particles. Many times we find that the texture is ideal, but the blending and mixing of the components produces pockets of only one of the ingredients. Any concentration of one of the soil components can create problems with respect to water movement and root development in the profile.

Soil Structure — Soil structure indicates how the particles of sand, silt, and clay are held together in clusters in a soil profile. A soil in good tilth will have 50 percent solids, 25 percent space for water, and 25 percent space for air. Soil structure is created by manipulating the soil, using methods such as hollow tining, spoon aerification, and through freezing and thawing. Soil structure often is destroyed through a combination of rainfall or irrigation and heavy traffic, including maintenance equipment and foot traffic. Excess water provides the lubricant for soil particles to slide together, quickly forming a solid, compact mass. Due to their minimal soil content, today's high-sand-content greens have little soil structure.

Soil Compaction, Bulk Density — Soil compaction or zones of high bulk density can be detected in an undisturbed soil profile. The zone or zones of compaction often can be found in a layer near the top of the

This profile indicates how poorly the soil was mixed during construction. Concentration of any one of the soil components creates problems in water movement and root development in the profile.

profile, due to heavy traffic. They also may be found two or three inches down in the profile, due to the compression of hollow-tine aerifiers at the base of their penetration. Soil compaction restricts root growth, inhibits the downward infiltration of water and nutrients, and restricts oxygen from entering the root zone. Nutrients remain at the surface of a compacted profile, which in turn encourages shallow root systems. Soil compaction can have a profound effect on the game of golf, too, drawing complaints from golfers who like their shots to "hold."

Hard Pan — In some profiles, thin, extremely compacted layers are present deep in the soil. These layers usually are due to the sliding effect of earth-moving equipment that manipulated wet soils during construction. These layers restrict roots, water, and air from moving down. Layers such as these have been known to remain in the soil profile for years.

Pore Spaces — The size of pore spaces can be estimated by using a medicine dropper and squeezing drops of water onto the face of the soil sample. If the droplets disappear quickly, the porosity may be excellent. If the drops of water ball up and move slowly through the soil, it may indicate insufficient pore space.

Hydrophobic Soils — Soils that become hydrophobic (commonly called dry spots) are very hard to rewet and should not be related to compaction problems. When a soil is allowed to dry excessively, natural oils, waxes, and organic materials sometimes prevent rewetting. Taking a sample at the edge of a dry spot will reveal the difference in the soil moisture in each side of the sample. Droplets of water on the dry side will confirm hydrophobic conditions. A hand aerifier can be used to open the soil, or a power aerifier can be used on larger areas. Apply wetting agents to help rewet the soil.

Anaerobic Soils — Anaerobic soils develop in the absence of oxygen. Aerobic microorganisms die out and anaerobic microorganisms take their place. Soil color and odor are two methods used for detecting these conditions. Under anaerobic conditions, iron in the soil will turn grey, blue, purple, or black. The soil has an offensive odor and will smell like rotten eggs, sulphur, or methane gas. The methane gas will, under the right conditions, manifest itself by causing the turf to rise up into bubble-like shapes. Black layers may form under adverse conditions, putting the turf under even greater stress. Deep aerification and drainage will help clear up these problems.

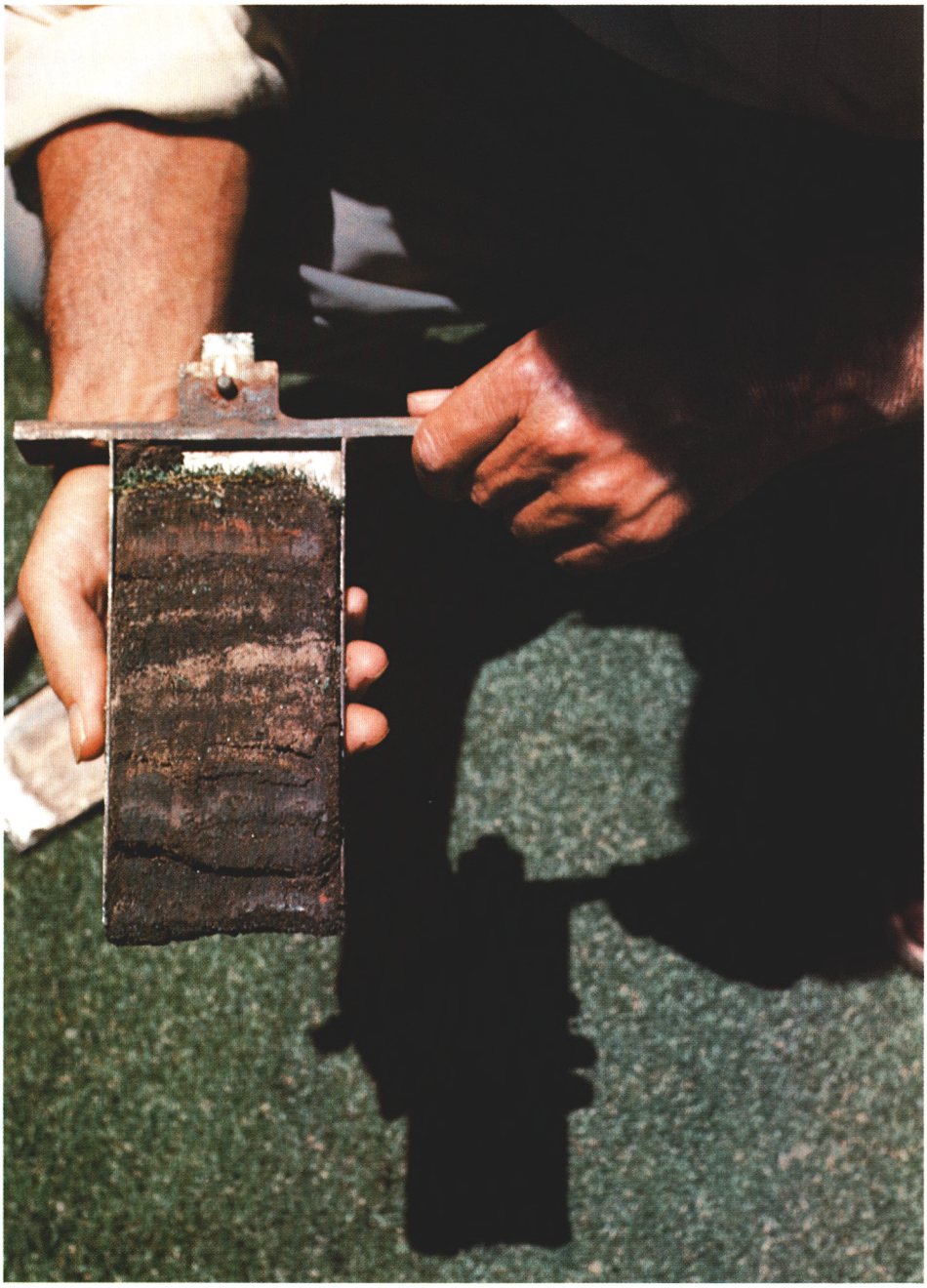
Layers — A layer or layers of unlike materials in the soil profile can contribute to plant stress, shallow root systems, and waterlogged soil. Layers can create false water tables in the profile. Research has demonstrated that, directly at the layer interface, water will be held until sufficient head pressure is developed to force it through the interface.

Layers in the soil profile often are created by ill-conceived topdressing practices. On old, established greens, a soil profile can sometimes reveal the number of people who have supervised the maintenance program in the past. In one example, a soil profile has revealed as many as seven different layers of unlike topdressing over a period of 12 years, by seven different managers.

It appears that some of the most damaging layers are those that consist of heavy topdressing over thatch and mat. These layers usually are well-preserved in the profile. This type of layer can be quite thin or very heavy, depending upon how much thatch and mat had accumulated before being buried with topdressing.

Roots — Root development can be observed by lifting away the soil with the point of a knife. Check for white, healthy roots and rhizomes. Use a microscope or a high-powered magnifying glass to observe the all-important root hairs. Another method is to soak the entire profile in a shallow pan of water and gradually wash away the soil until the roots are exposed. Record the depth and quantity of roots to compare with future

Soil drainage can be altered by manipulating the soil through hollow-tine aerification, and backfilling with a desirable topdressing mixture.



Several layers, created by topdressing with different materials, represent different management programs over the years.

profiles. Brown roots are dead roots. Excess quantities of these roots may indicate poor aeration.

Rhizomes — Check the rhizomes. The sampler cutting blades will have severed them. Take note of the size and diameter of the rhizomes. If they are in a viable, healthy state, they will be white and will snap in two. Observe the spears at the end of the rhizomes to see that they, too, are in a healthy state.

Drainage — To test the drainage and capillary pull of the soil sample, while still in the cutting shell, slant it about 45 degrees and drip water at the top of the sample. Saturate the top of the sample and check the time it takes the water to reach the bottom. If layers are present in the profile, the water will be stopped and will not begin moving down until saturation above the layer is reached.

Use of Color Slides as a Part of a Soil Profile Analysis

Taking color slides of your observations will provide a basis for comparison at a later date and is highly recommended. Write down a description to match the photographs. In this manner, an excellent record will be developed in order to guide a sound management program. Good pictures can be used for lectures and/or published articles. Many agronomists, including USGA Green Section personnel, frequently publish articles with profile photographs to illustrate their main points. Slides are a convenient way to show Green Committees and others the problems that may exist, and why they should be corrected.

Preserving Soil Profile Samples

Preserved soil profile samples can be used in many ways. They become permanent, life-sized records of a soil improvement program, and can be used for teaching purposes.

Following are instructions for preserving soil samples.

Preserving Soil Profile Samples

Preserved soil profile samples can be used in many ways. They can become a permanent record of a soil improvement program, or they can be used for teaching or demonstration purposes. Preservation is simple.

Prepare mounting bases by cutting 4" or 8" pieces of either ⅛"- or ¼"-thick plywood. Sand the edges and spray both surfaces and edges with clear epoxy enamel and allow to dry. A supply of these can be made before taking the soil samples.

After taking the soil profile sample, carefully slide it on the prepared mounting base. Position the sample so that it is centered.

While the sample is still moist, thoroughly spray it with a clear epoxy enamel coating, continuing until the sample is uniformly saturated. When dry, carefully turn the sample over and spray the other side. Be sure to spray the sides, too.

After the first coat is dry, spray again over all surfaces and edges.

Repeat spraying to accumulate at least three coatings over the sample. Sandy samples will usually require more coatings than heavy clay soils.

After the final coat is dry, apply silicone glue to the underside of the sample and attach it to the center of the mounting board. Place a label with your name, date, location, and other pertinent information at the top or bottom of the mounting base.

Post-Emerge Crabgrass and Goosegrass Control: Practical IPM

by STANLEY J. ZONTEK
Director, Mid-Atlantic Region, USGA Green Section

STRIVING FOR excellent quality golf turf during times of high environmental concerns presents an interesting challenge for today's turf manager. How does one use less chemicals and *still* maintain the quality, pest-free turf the golfers want, expect, or demand?

To answer the question, consider an old idea in the context of today's needs and modern technology; that is, the post-emerge control of crabgrass and goosegrass.

By way of background, many of today's golf course superintendents became educated, trained, and experienced in growing grass during the era when pre-emerge herbicides for crabgrass and goosegrass control were commonly used, especially in the crabgrass and goosegrass zones of this country. There was choice upon choice of materials to use to control the "curse" of the crabgrass.

It is not surprising that of all the weed problems on golf courses, golfers almost universally recognize weeds like *Poa annua* (especially when it's seeding), dandelions, crabgrass, and goosegrass. No doubt most golfers are exposed to these weeds through experience with their own home lawns.

Golfers do not like weeds, and neither do golf course superintendents, particularly when their job performance as turf managers is sometimes gauged by their ability to grow weed-free stands of grass. Golf course superintendents have at their disposal several relatively inexpensive, reliable, and effective pre-emerge herbicides. In the crabgrass zones of the country, pre-emerge products have been and continue to be routinely applied every spring on nearly all greens, tees, and fairways, and on many acres of rough, in order to control a weed problem before it ever develops.

In some ways, it is almost a perfect program: treat everything so that complaints and problems with crabgrass never are received because these weeds never develop. To many, it's worth the money both in terms of the cost of the products themselves and in reduced aggravation for the golfers and the superintendent.

As with most aspects of turfgrass management, however, there are no panaceas. To some extent, most pre-emerge herbicides produce some root-stunting effects. It is

Post-emerge sprays work! A misapplication with Acclaim on a perennial ryegrass fairway resulted in an infestation of crabgrass.

ironic that golf course superintendents work hard to develop deep root systems and then apply a pre-emerge product which either damages the roots or suppresses their development. This seems like an agronomic contradiction.

Further, the various pre-emerge materials have varying lengths of residual presence in the soil. Pre-emerge herbicides control weeds by controlling germination of seeds, but most of these materials do not distinguish between germinating weed seeds (the target) and the germinating grass seeds which may be overseeded into the turf during the fall.

It is a concern, then, that a pre-emerge application in the spring can affect overseeding results in late summer or fall. Nevertheless, a properly timed application may allow for good weed control without affecting fall renovation work. When should these materials be applied during the spring? Not too early — to allow turfgrass roots to develop beforehand. Not too late — so as not to miss the early germinating crabgrass. Not too early, or else herbicide residual activity may be lost and allow a weed-grass breakthrough at the end of summer. Not too late — the residual can carry over into the fall renovation period, jeopardizing seed germination. And let's face it, there's nothing much worse than losing turf during the summer and then not being able to establish a new stand of turf during the fall because of an earlier pre-emerge application.

How about splitting the applications? Manipulating rates? See the point? It is a balancing act. Often, it is a choice of the least of several evils.

While pre-emerge materials are convenient, they do present several real limitations and problems. There are no panaceas, but the fact is that when pre-emerges are used, generally there is little or no crabgrass. An acceptable situation? Only you can answer this question.

An Alternative

Many of today's turf managers cannot remember the days before pre-emerge herbicides were available to our industry. Yes, grass was grown, successfully grown, without the use of effective pre-emerge crabgrass killers we have today.

How was this done? It really was an early form of IPM; using management techniques and the post-emerge materials which were available. Good management practices produced good grass density. The old adage "the best weed control is a thick turf" is as true today as it was decades ago when it was first spoken. This is particularly true as it pertains to crabgrass and goosegrass control. Golfers should follow this same advice for their home lawns. Raising the cutting height results in less crabgrass.

Cut it long and keep it adequately watered and fertilized for good density. Then, apply a post-emerge product if weeds still develop. This is how crabgrass and goosegrass were managed before the pre-emerge era. However, this program was not a panacea either! Golfers then, as now, did not like long grass.

Most of the post-emerge chemicals available at that time were harsh, leaf-burn types of products. DSMA, AMA, and others all were commonly used post-emerge herbicides. Several are still in use today, particularly on bermudagrass, which is more tolerant of these materials than are cool-season grasses. These products were harsh, and they often required repeat applications (especially on cool-season grasses) in order to kill the weeds without harming the turf. There were no soil residuals, though, and you could always spot-treat.

Fortunately, today there are available new post-emerge crabgrass control herbicides that are especially useful for turf managers growing cool-season grasses in the Transition Zone. Turf managers responsible for growing bermudagrass have had some excellent post-emerge products to use, but not until recently have safe, effective materials been available for use on cool-season grasses. The first of this new group of materials is Acclaim, and others are in the works.

Thus, the turf manager growing cool-season grasses finally has a choice of two options when it comes to controlling crabgrass and goosegrasses. He or she can routinely apply pre-emerge herbicides to many areas of turf each year or, using a combination of good management practices to increase grass density and suppress crabgrass germination, post-emerge herbicides can be applied on an as-needed basis to keep grassy weeds under control.

Post-emerge crabgrass control is a practical approach to IPM. It may not be practical on all areas, but new products are allowing us to resurrect an old idea: post-emerge control of grassy weed problems. You will treat only the known problem areas, leaving the rest alone. There are no negative root effects; you can seed anytime you want; less time, labor, and money are spent; much less area is treated with chemicals. All are beneficial side-effects of a post-emerge program.

Give this post-emerge approach a try. Take one fairway, or try it on a few tees or a green. Do not apply a pre-emerge. See what happens. Tell your boss. Communicate what you are trying to do to your supervisor. You might be surprised; maybe, just maybe, crabgrass and goosegrass will be less of a problem than you expected. You'll never know until you try. If some crabgrass develops, control it with a post-emerge program. Heck, you could even hand-weed! This old technique is still effective. IPM, using a knife.

If weed pressure is just too great or if you do not have the time, labor, or quality sprayer necessary to accurately apply these new-generation materials, then the use of pre-emerge herbicides may still be the best program for you. You'll never know until you try.

Post-emerge control of crabgrass and goosegrass; it's an old idea that has been brought back to life with the development of new products. Give it a try.

Divoting defeats most pre-emergent weed control, necessitating post-emerge control.

"Water Watch" Programs: Stream Water Quality Monitoring

by NANCY P. SADLON
Environmental Specialist, USGA Green Section

WATER — a priceless resource! Its quantity and quality are watched over by more organizations than ever before, ranging from local citizen groups to national and Federal government programs. "Water Watch," "Save Our Streams," and "Stream Quality Monitoring" are just a few titles used by various organizations for their water monitoring programs.

It is estimated that 45 of the 50 states have water protection programs of one kind or another, with more than 1,000 "water watching" subgroups involved. A large majority of these groups are comprised of concerned citizens who are taking the initiative to monitor their communities' lakes, streams, and rivers. Many are trained by state or independent environmental groups on what to look for and how to analyze water quality.

Citizen participation is considered vital to save America's surface waters. Federal and state agencies are only able to monitor a small portion of the nation's surface water, leaving a large percentage unprotected. Although some groups do more elaborate testing, including chemical testing, most citizen monitoring programs do simple biological monitoring tests. A golf course committed to addressing the water issues of the 1990s should be committed to water quality protection. Being aware of community monitoring programs and taking an active role in monitoring on-site water resources are good ways to start understanding water quality and setting priorities for its protection.

Biological Monitoring

Biological monitoring involves trapping, identifying, and recording stream organisms to determine water quality. It provides evidence of pollution problems that chemical sampling often misses.

The technical name associated with biological monitoring is "macroinvertebrate bioassessment." The term *macroinvertebrate* refers to living organisms lacking a backbone and large enough to be visible to the naked eye. These organisms provide an excellent source for stream quality assessment work because, by nature, they are restricted to the immediate habitat and cannot escape water quality changes. In freshwater streams, this group includes insects, crustaceans (crayfish), mollusks (clams and mussels), gastropods (snails), oligachaetes (worms), and others.

Macroinvertebrates live in sand and mud, or attached to submerged rocks, logs, sticks, and vegetation. Stream flow provides a steady supply of necessary organic material on which the organisms feed. When the water becomes polluted, macroinvertebrate populations are adversely affected and require considerable time to recover. In a monitoring program, the overall health of the water is assessed by determining the number and variety of organisms present. In general, a greater quantity and diversity of organisms indicates better water quality.

Water is a priceless resource to be protected. Biological monitoring of stream water quality involves periodically trapping and identifying stream organisms.

Monitoring Methods for Streams

A variety of sampling techniques and equipment are utilized by water monitoring groups. Analysis often involves measuring dissolved oxygen, pH, and identification of stream organisms. Monitoring stream organisms (macroinvertebrates) involves collecting the organisms in a fine mesh seine from a small riffle area on the stream bottom. The macroinvertebrates are identified, counted, and returned to the stream, or taken to a classroom for detailed identification.

Water Quality Assessment

Interpretation of stream quality data involves analyzing the diversity and type of organisms found in the sample. Macroinvertebrates are dependent on one another, so loss of one species impacts others. Additionally, the organisms found in the macroinvertebrate group have different tolerances for low oxygen levels or toxic substances associated with pollution. Therefore, the presence or absence of certain organisms can be related to the water quality. One simple guideline for stream assessment, using the rock scraping survey method provided by the New Jersey Water Watch Program, is as follows:

Stream Quality Rating	Organisms Present
Good	Stoneflies, mayflies, and caddisflies
Fair	Caddisflies only
Poor	Tubeflex worms and red-colored midget larvae dominate sample

Results are most accurate in April, May, or June. Later in the summer, fewer stoneflies will be observed.

There are more elaborate assessment procedures used to identify and rate organisms; however, the premise is the same. Recording the aquatic life found in the stream and applying knowledge of each species' sensitivity to pollution provide techniques to rate water quality.

Summary

Citizen monitoring programs are rapidly growing throughout the nation. Efforts are underway to establish a national group or organize the volunteer groups and to standardize testing procedures. Biological monitoring is not difficult to master. Middle school and high school students are participating nationwide. Data from numerous citizen groups have, in many areas, gained considerable credibility and are used in government database programs and by national water quality organizations such as the Izaak Walton League.

Important indicators of pollution entering a stream can be identified by a simple stream monitoring program. Participation in stream monitoring provides a unique opportunity to increase educational awareness. It makes sense to be aware of your golf course stream's current water quality and to conduct your own "water watch" or get help from a local citizen monitoring group.

Whom to Contact?

Most states have a Division of Water Resources, as part of the Department of Natural Resources or Department of Environmental Protection, that can direct you to local water watch groups in your area.

The USGA-sponsored Audubon Cooperative Sanctuary Program for Golf Courses also has a water watch program in which you can participate. For more information, contact the Audubon Society of New York (phone 518-767-9051).

The New Jersey Water Watch Program works with high school students on educational programs about water quality testing procedures.

Why Not Pure Sand Greens?

by JAMES T. SNOW
National Director, USGA Green Section

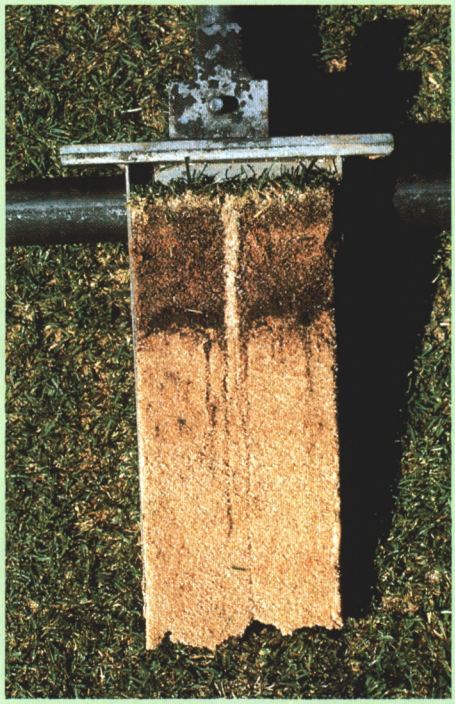
HERE WE GO AGAIN! Calls and letters are coming in from people or about people who are going to build pure sand greens (using a uniform coarse sand, no less) instead of USGA specification greens because of some article they read recently in a widely distributed turf publication. And why not? After all, the article says that all-sand greens are easier and cheaper to build . . . nice and simple. All the complicated, high-tech, unnecessary, costly steps have been eliminated. No need to worry about today's inconsistent organic materials, or about gravel drainage beds or intermediate coarse sand layers.

Worried about water retention? Just mix some water-absorbent polymers or other unproven inorganic amendment into the top few inches of the sand profile, place the whole 12" rootzone on top of the existing soil base with some drain lines installed in it, and grow healthy, care-free turf.

Revolutionary, you say? No, it isn't. Sounds too good to be true, you say? Yes, it is!

There's usually a price to pay for taking a shortcut, and hundreds of superintendents (and their clubs) around the world have paid a high price for taking the "easy" way with pure sand greens and untested modifications. Our experience tells us this:

- Pure sand greens built without a perched water table are often extremely droughty and experience severe dry spot problems.
- There is no buffering capacity in pure sand greens, and wide shifts in pH can occur very quickly.
- Pure sand greens often require extremely high rates of fertilizer during establishment and for several years thereafter. Rates as high as 30-40 lbs. N/1,000 sq. ft. or more per year have been reported. Potassium, phosphorus, and micronutrients also must be applied more frequently and in greater amounts.
- Disease problems often are much more severe on pure sand greens. It is a medium with extremely low microbial activity and offers almost no resistance to take-all patch, root pythium, and other root diseases.
- Lateral movement of water through the sand rootzone to drainage tiles may occur very slowly in some sands, resulting in wet areas between tiles and dry streaks over the tiles.
- Pure sand greens often are harder and less resilient than modified rootzones. Surface wear and root and shoot damage occur more readily, particularly with sharp sands.



The grow-in layer on a pure sand green can cause layering problems that eventually lead to black layer.

- According to work by Dr. James B. Beard, pure sand rootzone construction has a significant negative effect on root hair development and maintenance compared to a properly mixed rootzone.
- Greens built of unmodified, round sands that fall in a narrow particle size range are unstable. Footprinting and tire tracking can occur for years after construction.
- The grow-in layer of sloughed-off root organic material on pure sand greens is often quite dense. This layer can create a perched water table in the top 3- to 5-inch zone, and black layer frequently results.

As far as adding water-absorbing polymers and other unproven inorganic amendments into the top several inches of the profile is concerned, this is nothing more than gambling with other people's money and the golf course superintendent's job security. The Green Section specs are based on decades of field experience and university-based research. Unproven alternatives should not be promoted until thoroughly researched and field tested.

Proponents of pure sand greens and other "fast and easy" methods suggest that the golf course hire itself a good superintendent, since a top superintendent can grow grass on anything, including concrete. This is a copout! Lousy construction eventually begets lousy turf. The golf course often pays big bucks to get itself out of the mess, and the superintendent often pays with his job.

Last, but not least, how can the golf industry accept pure sand greens, or any other method, that requires extremely heavy use of water and fertilizer? It's environmentally irresponsible. Who wants to be first in line at an environmental forum and be challenged about what happens to 40 lbs. N/1,000 sq. ft./year applied to a droughty, pure sand rootzone?

Space in this column does not permit a thorough rebuttal to all of the misleading statements used to rationalize pure sand greens and other untested methods. The fact is, USGA greens offer the best compromise to allow a green to drain properly and to resist compaction while holding reasonable amounts of moisture and nutrients for plant growth. Don't be fooled by anyone into thinking that greens can be built easily and cheaply without having to pay for it later with interest.

Pure sand rootzones and their untested modified versions should not be encouraged or condoned.

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TURF TWISTERS

BEETLES

Question: Small, shiny, black beetles are often seen scurrying across the greens. We often find them in or around partially filled aeration holes. Are these black turfgrass Ataenius beetles, and what should we use to control them? (Illinois)

Answer: Fast-moving beetles are most likely ground beetles or rove beetles. Neither feeds on turfgrass, and they probably are seeking cutworms or other insects in the aeration holes. Ataenius beetles crawl very slowly and usually burrow into the turf as soon as they land on the putting surface. Beneficial insects such as rove and ground beetles are extremely sensitive to pesticides, so always make a positive identification before spraying.

BUGS

Question: I have large black-and-yellow wasps in my sand bunkers during the summer. They scare the golfers, but no one has yet been stung. I'm reluctant to make an insecticide application in the bunkers unless it's absolutely necessary. Are these wasps dangerous, and how do I get rid of them? (Indiana)

Answer: Wait a minute! The insect you describe is probably a beneficial insect called cicada killer or a closely related species. The aggressive males hover above the burrows but don't possess a stinger and are harmless. Females will sting when provoked, but have little nest-guarding instinct. In fact, cicada killer wasps are considered beneficial because they capture many pest insects and use them as food for their young. Control of the more aggressive yellow jackets and hornets is prudent when they pose a threat to golfers. We agree with your reluctance to spray bunkers to control these wasps.

AND BITES

Question: Fire ants can be a real pain, in more ways than one. What is the latest on effective control measures for these nuisance pests? (Florida)

Answer: Fire ants inflict a repeated sting that produces a burning itch. Unfortunately, there is no new miracle cure on the market for their eradication. Here are a couple of hints, however, to help control these pests. When using a granular or powder insecticide to spot treat fire ant mounds, apply the product only when the area is free of surface moisture or dew. When these materials become wet, the ants' ability to carry these materials into the mound is diminished and the product is ineffective. Also, resist the temptation to stir up the mound. This disrupts the ants' normal behavior and further decreases effective control. Last, but not least, always apply pesticides at the manufacturer's label recommendations and wear appropriate protective clothing.