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Putting the Water Puzzle Together

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Cover Photo:
A good irrigation system is a key tool for maintaining top-quality golfing turf — 15th green, West Course, Winged Foot Golf Club, Mamaroneck, New York.

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The "Irrigation Man" puts puzzle pieces together.

Putting the Water Puzzle Together

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IF YOU PLAN a long and successful career as a golf course superintendent, a sound, basic understanding of water management is the first prerequisite. Of course proper practices in mowing, pest control, cultivation, drainage, and nutrition will be important, but proper and correct irrigation practices are essential. They stand alone in the production of good turf for golf.

For decades, golf course superintendents have been encouraged to apply water deeply but infrequently. The healthiest grass plants are those with deep and extensive root systems.

The idea is to allow the upper root zone to dry out for a few days before applying the next irrigation. This technique, called wet-to-dry management, promotes the deepest possible root growth. Unfortunately, most irrigation schedules are not managed this way.

The problem is complicated even more by natural rainfall. Soils that are consistently too wet invariably lead to greater compaction and soil problems, heavier fertilizer requirements, weed and disease problems, and shallow rooting.

The turfgrass plant is composed of approximately 90 percent water, which is essential for every stage of growth, from seed germination to maturity. Water plays an important role in photosynthesis, cell development, temperature control, and nutrient translocation within the plant.

Water content within the plant is reduced during drought conditions. Most turgrasses will survive plant water losses of 30 percent or more. Moderate water stress may actually enhance plant quality by promoting deeper rooting, and increase the plant's resistance to water stress. During extended drought periods, many cool- and warm-season turfgrasses enter a dormant stage. Kentucky blue-

grass, perennial ryegrass, bentgrass, tall fescue, bermudagrass, zoysiagrass, centipedegrass, and St. Augustinegrass all have a drought dormancy mechanism. Once the drought is broken, new growth is initiated. Management and environmental factors, such as temperature, fertility, mowing height, etc. directly affect drought tolerance of turfgrasses.

Turfgrasses can also suffer from too much water. Root rot, caused by *Pythium* spp. is most active on young grasses grown on poorly drained wet soils. Excessive soil moisture frequently results in a condition called wet wilt. The root system cannot function because essential oxygen is displaced by excess water in the soil pore space. Turfgrass roots require 30 to 40 percent open pore space for optimum activity. If conditions of excess water persist, soils often become anaerobic (without oxygen), producing the condition called black layer. It is difficult to maintain turfgrass water supplies within this narrow range of too much or too little.

(Top) If water is applied during the "do not water" times indicated on this chart, the turf may remain wet long enough to cause the appearance of symptoms of disease caused by fungi.

(Above) Deep cultivation — a new tool for better water management.

THE TURFGRASS plant actually requires only a small amount of water for growth and development. Most water within the plant is used in the translocation process — the movement of water-soluble materials from one part of the plant to another. Practically all of this water is lost from the plant through transpiration, that is, water lost in vapor

The soil probe, an old tool essential to better water management.

form from the stem and leaves. Transpiration is a necessary biological plant function that helps cool the plant. Many people are surprised to learn an estimated 99 percent of the water taken up by the turfgrass plant is lost to the atmosphere, while only one percent is used for growth and development.

The term evapotranspiration refers to water lost from the soil by evaporation and by transpiration from the plants growing on it. It relates to the water use rate of any crop, and it varies with climatic conditions. For example, the ET rate (evapotranspiration rate) is increased by factors such as sunlight, soil and air temperature, humidity, and wind speed. Turfgrasses use the most water on sunny days with low relative humidity and moderate wind speed. High ETR days occur mainly in the summer, with much lower rates in the spring, fall, and winter. Your local weather bureau and state extension service have information on evapotranspiration rates for your area.

Turfgrasses differ in their rates of water use. Grasses with low rates of water use may require less than 1.0 inch per week, while those with high rates may need 2.5 inches per week in the summer. For example, bermudagrass requires about 1.0 inch per week, whereas tall fescue requires 2.0 inches per week during the summer in the Piedmont of Georgia. Bentgrass putting greens at times during the summer have water use rates of up to .33 inch per day. It is possible to estimate with reasonable accuracy the general water requirements for putting greens, tees, fairways, and roughs if the grass species and climatic conditions are known.

TALLER mowed turfgrasses have a higher evapotranspiration rate than shorter mowed turf because of their open canopies. They require less frequent irrigation, however, because they have a deeper root system that can extract water from the lower root zone. Shorter clipped grasses have fewer roots, and they usually require more frequent irrigation. A turfgrass maintained at a taller height and mowed frequently will help reduce evapotranspiration water loss.

Raising the mowing height during drought is best for turf. Mow frequently enough so that no more than one-third of the leaf tissue is removed in any one clipping. This old philosophy helps increase turf survival and decrease the rate of water use. The rooting depth, growth rate, soil and climatic conditions, and turf species determine the actual rates of water use.

Putting green grasses are mowed at heights of 3/16 of an inch or less on many golf courses. Closely mowed turf has a tendency to develop shallow roots. Healthy root systems of shorter mowed turf, however, benefit from deep and infrequent irrigation. Studies have shown a sound water program is equal to or more important than the mowing strategy for today's golf turfgrasses.

A deep and infrequent irrigation philosophy has many advantages for the golf course superintendent. The primary goal is to wet the entire root zone, but avoid saturation. The better programs strive to provide optimum root zone moisture for only level ground and lower areas. The higher and drier areas should be treated with supplemental water and aerified if necessary to help prevent dry wilt. This supplemental irrigation helps avoid overly wet soil and unhealthy conditions in lower areas.

Using this type of deep but infrequent water management, the program objective is to wet the root zone deeply once or twice weekly. A good guideline is to supply about one inch of water per week during dry weather. One inch of irrigation for one acre requires about 27,000 gallons of water. Most 18-hole courses in the Green Section's southeastern region irrigate about 50 acres, so the total water output is significant.

Once water is deeply applied throughout the root zone area, subsequent irrigation is based on evapotranspiration rates and soil drainage. For example, many courses in the Southeast allow about 30 to 40 percent of the root zone to dry before the next irrigation of their hybrid bermudagrass fairways. Drying of the upper six to eight inches of fairway soil may take five to seven summer days. The measured precipitation to rewet the root zone may be from 0.5 to 1.0 inch of water, depending on soil conditions.

A blue-green leaf color generally indicates a shortage of moisture. Every golf course superintendent has one or more drought stress indicator areas, usually where excessive thatch, sandy soil, or non-uniform irrigation coverage exists. Some isolated dry areas may reappear within two to four days after the last deep irrigation. It is better to hand water these areas, especially on the putting greens. Most other locations will still have adequate soil moisture that is easily detected with a soil probe.

Isolated dry spots or hydrophobic areas are common in golf turf. Soil fungi and bacteria have been commonly associated with them. Most golf course super-

intendents have had success with spot aeration and rewetting isolated dry spots individually with a hose and shower nozzle. Wetting agent applications, such as the new pellet or granular formulations, temporarily help alleviate the isolated dry spots.

MOST golf courses will have fewer dry spots with the implementation of a deep irrigation program. Water will move both laterally and horizontally through the root zone with the higher water volume. One longer irrigation period or several repeatable shorter cycles are usually effective in rewetting the soil profile uniformly. Repeatable cycles are helpful on heavy texture soils or soils with lower infiltration rates. The irrigation cycle is repeated every few hours to allow for infiltration and to reduce water runoff.

A deep irrigation philosophy is complemented by a vigorous aerification program. It is difficult to implement deep irrigation on compacted soils. The soil must be conditioned to accept 0.5 to 1 inch of water a night. Aerification helps relieve soil compaction, improves root growth, and allows for more rapid water movement into the root zone.

For putting greens, the new deep-tine aerification equipment is very effective in improving water infiltration rates and soil conditions to a depth of 10 to 12 inches. Previous aerifiers only penetrated three to four inches. The deep-tine aerifier allows much deeper root zone modification. Incorporating a good topdressing soil into the holes has also helped maximize root growth. The new aerification equipment makes it possible for more clubs to adopt the deep irrigation philosophy.

Spikers and slicers are excellent tools to relieve soil compaction in the upper root zone temporarily. These tools should be scheduled on a weekly or bi-weekly basis where improved water penetration is needed. Spikers and slicers help water move through surface crusts, black algae, topdressing layers, and thatch. They also assist in the exchange of soil oxygen in the upper root zone.

Aerifying according to specific turfgrass needs will also aid in the success of this irrigation philosophy. Most water is applied to turfgrasses during the summer. Aerifications enable water to enter the soil during subsequent irrigations.

Irrigating on a daily schedule during dry weather is a less desirable alternative. Daily irrigation does provide some insurance against drought, even though the long-term agronomic effects are most undesirable. Wet areas frequently appear in low and poorly drained locations. Black algae is common.

Daily irrigations sometimes help the golf course superintendent maintain a better relationship with certain club members. These players request softer playing conditions, especially on the putting greens. They expect every approach shot to stop at or very close to their pitch marks, regardless of how the shot was played. Unfortunately, they do not realize their request is not only detrimental to their own long-term enjoyment of the game, but to the long-term quality of the golf course turf as well. The USGA Green Section has long advocated firm putting greens, to the benefit of the golfer and his course.

MANY GOLF courses establish a permanent, repeatable irrigation schedule, such as every other night, twice weekly, or once weekly. This practice is often, but not exclusively, found at golf courses with limited labor. The schedules may work with some success from time to time, but they are predetermined to fail because they are largely unattended and not associated with actual daily water use rates. Overwatering or underwatering invariably occurs. There is absolutely no sure way to carry out a proper irrigation program without involving the daily good judgement of an irrigator.

The best superintendents use a soil probe to help determine when and how much to irrigate. The soil probe is an excellent tool to check turfgrass root depth and soil moisture. Few other more reliable tools exist in the business. Insert the probe into the soil. The resistance of the soil to insertion, along with soil moisture texture and degree of root systems, will help determine irrigation requirements.

EARLY MORNING seems to be the preferred time for irrigation because it reduces disease problems. For some managers, this may mean 4 a.m., and for others 10 a.m., but whatever the time, the irrigation program must be started early enough to complete the watering cycle before it conflicts with the day's play.

Most disease-causing fungi require 16 to 22 hours of free moisture for disease symptoms to occur. When to water is a very important question. Many times the answer is dictated by the use pattern of the turf. Let's assume that dew falls at 8 p.m., and it might not dry off until 10 a.m. the following morning. With this in mind, the turf is at a 100 percent relative humidity for 14 hours. Under normal circumstances, this is not long enough to promote disease. If the turfgrass is watered at 4 o'clock in the afternoon, however, it will not dry off before dew falls at 8 o'clock. The wet period has been extended by four hours, and now it falls in the range of time necessary for disease organisms to infect turfgrass. If the turf is watered at 9 o'clock in the morning, the wet period is extended again by one to two hours, and the minimum time requirement for infection is present. In either case, it is important to remember not to water turf at any time that will extend the natural wet period.

Turfgrass can be watered during the day, so long as it is allowed to dry before the evening wet period. It is also acceptable to water in the early morning, at 3, 4, or 5 o'clock. Extra irrigation may sometimes be needed for certain maintenance requirements during undesirable irrigation times. The golf course superintendent should anticipate such circumstances and plan preventive fungicide applications as they are needed.

Night watering has been performed on golf courses for many years. The night hours are the most desirable time to irrigate larger turf areas without interfering with play. Other nighttime advantages include lower evaporational loss, reduced wind, lower temperatures, lower plant stress, and a longer time for water to soak into the soil.

TODAY, most golf courses have automatically controlled irrigation systems. With proper design, engineering, installation, and system maintenance, the modern golf course superintendent has an extraordinarily accurate means to finally solve the water puzzle. But automatic irrigation systems are not really automatic. They alone cannot fit all the water puzzle pieces together. They alone can never solve the problem. The solution lies only with the golf course superintendent and his basic understanding of water management fundamentals. That's the way it is and that's the way it will always be.

NuMex Sahara — A New Seed-Propagated Bermudagrass

by DR. ARDEN BALTENSPERGER
New Mexico State University

NuMEX Sahara (formerly designated as NMS-1 and NuMex S-1) is a seed-propagated bermudagrass released by the New Mexico Agricultural Experiment Station, in February of 1987, funded by the United States Golf Association.

The initial crossing of the eight clones providing the genetic background of NuMex Sahara was made in 1980. These were selected on the basis of seed yield and the performance of their progeny for such attributes as shorter internode length, darker green color, greater density, reduced regrowth after clipping, and resistance to a bermudagrass stunt mite. Plant selections were made throughout the development, both in the greenhouse and in the field. Although no systematic method was used to provide resistance to drought stress, some field selections were made in soil moisture stressed environments.

DURING the early years of this breeding project, many reservations and questions arose about developing improved seed-propagated bermudagrasses. At that time, many felt a seeded bermudagrass was not necessary, since so many excellent vegetative varieties were available. It was decided an improved seeded cultivar was needed for large areas (such as golf course fairways) where seeding is the best method of establishment. It was obvious common bermudagrass offered many good-looking turf-type plants, but it was not known if the desirable traits would be easily passed on to offspring in a seed-propagated variety. Therefore, genetic studies were aimed at determining the breeding behavior of several important traits. These studies led to using multiple cycles of recurrent phenotypic selection for both seed production and turf characteristics.

After the official release of NuMex Sahara, an exclusive release was granted by the New Mexico Crop Improvement Association (NMCIA) to Farmers Marketing Corp., of Phoenix, Arizona. This company agreed to handle all classes of certified seed, and pay a royalty to the NMCIA for distribution after expenses to NMSU and the USGA.

Farmers Marketing Corp. established a breeder field of NuMex Sahara in early July of 1987, harvested a winter seed crop in 1987-88, and a good summer seed crop in 1988. Over 100 acres of foundation fields have been established in Arizona and California, and a limited supply of commercial seed is expected to be available in 1989. Considerable care has been exercised to maintain genetic purity. Over 20,000 plants were planted in the isolated breeder field, which was followed by careful removal of off-type plants.

Plant Variety Protection (PVP) was applied for in 1987, and granted by PVP certificate no. 88800010 on March 11, 1988.

Dr. Baltensperger shows improved summer color, density, and uniformity on the NuMex Sahara plot vs. common plot.

NuMEX SAHARA appears to have most of the desirable attributes of common bermudagrass. However, it is denser and lower growing than common, which is primarily a result of breeding for shorter internode length. This variety has been given a higher turf quality rating than common at many test locations, partially as a result of better summer color and greater density (Table 1).

In tests at NMSU, NuMex Sahara has shown less damage caused by the bermudagrass stunt mite and faster spring green-up than common. In the first year of a drought study conducted by Dr. James Beard and associates at Texas A&M University, NuMex Sahara rated high in drought avoidance (as measured by leaf firing) and drought resistance (as measured by the percentage of shoot recoveries).

Since this new variety is seed propagated, like common, seedhead production is necessary. NuMex Sahara will produce seasonal unsightly seedheads, but this will be a problem only on turf managed under low maintenance. NuMex Sahara is expected to resist winterkill slightly better than common. The seed propagated variety Guymon, however, has shown excellent cold tolerance, although it is quite coarse textured and should be considered for the colder parts of the bermudagrass growing regions.

Although NuMex Sahara is not as fine textured as many of the hybrid or vegetative propagated varieties of bermudagrass, it is less prone to scalping and thatch buildup. Because of ease and lower cost of establishment, NuMex Sahara should be acceptable for use on large areas such as golf course fairways, parks, athletic fields, and some home lawns. Because of the increased interest in seed-propagated bermudagrasses, the National Bermudagrass Test results are now being reported in separate tables, *i.e.*, vegetative cultivars and seeded cultivars. This will be helpful to those who have chosen seeding as the desired method of establishment.

NuMex Sahara should be managed using the same good cultural practices that have been successful with common and other medium-textured bermudagrasses. Although some selection pressure for nitrogen and iron efficiency was used in the development of this variety, it still requires large quantities of nitrogen fertilizer for good quality turf, especially under intensive use. Iron fertilization may also be required, particularly in the desert Southwest where iron deficiency symptoms often occur.

Low-temperature color retention in bermudagrass is notoriously poor, and NuMex Sahara shows little or no improvement. However, it is suggested that in areas of the Southwest, where winterkill is not a problem, a late summer renovation be considered. Fall color has been improved in experimental plots at NMSU, with a renovation treatment involving verticutting and scalping in mid-August, plus continued close mowing at about ½ inch or less. Hopefully, cultural experiments may soon be initiated to better determine the most desirable management practices for NuMex Sahara.

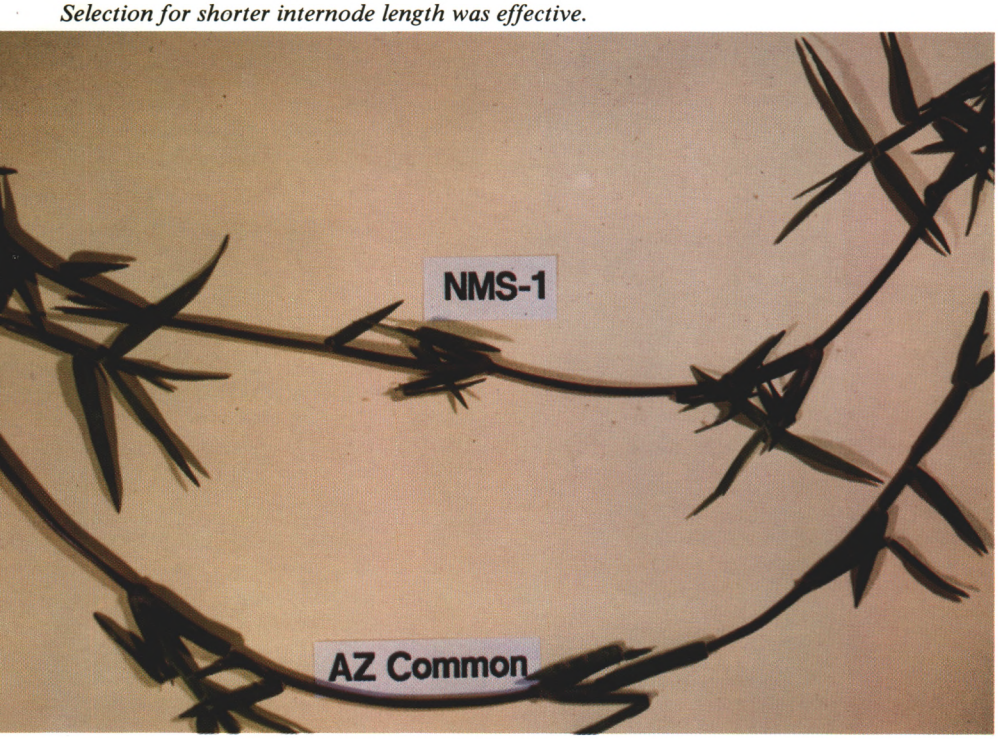
Table 1.
Mean turfgrass quality ratings of three commercially available seed-propagated bermudagrasses at 14 locations in 1987.[1]

	Mean Turfgrass Quality Ratings[2]
NuMex Sahara	5.0
Common	4.6
Guymon	4.4
LSD 0.05	0.2

[1]Data from p. 5 of PSI No. 5 National Bermudagrass Test — 1986. Progress Report 1987. Sponsored by USDA, ARS, Beltsville Agric. Res. Center, Beltsville, Md. 20705.

[2]Rated from 1 (least desirable) to 9 (most desirable).

Selection for shorter internode length was effective.



The Lone Ranger Rides Again

by TIM P. MORAGHAN
Agronomist for USGA Championships

Armed and ready with a smile and helping hand, the trained course marshal is a friend in need to the players and an important asset to the golf course superintendent and professional.

THE ANNOUNCER in the tower behind the 18th green has informed the television audience that your blind recovery shot from under the tree in the deep rough has rolled to within two feet of the hole. As you stride confidently to the green, the crowd roars with appreciation of your shot. You realize making this putt will win you the Open Championship, and your dreams will become reality. The final putt is on line to the hole. As the ball falls into the cup, you hear, "Hey, Bozo! Your foot glued to the brake pedal? Come on, move it!" You snap to attention to see that the traffic jam that has trapped you for hours is breaking up and now you can head home. Why do they call it rush hour traffic when nobody moves?

After a week of fighting traffic and hustling through that special project for the boss, all that is on your mind is that 9:20 a.m. starting time at Peaceful Hills Golf Course. No waiting, no hassles, a place where you can play your fantasy round. Saturday morning is here, and off you go to meet your friends and enjoy a leisurely round of golf and finally relax.

Clubs on the cart, you head to the first tee to look down that sea of green, ready to pound your drive. What's this? No movement, carts backed up everywhere. People yelling and screaming at one another, balls and turf flying in all directions, and no room to move. You were better off caught in rush-hour traffic. Your partner, sitting reading the latest golf magazine, states there are over 21 million golfers in this country. How about that. Hearing this, you wonder to yourself if they all aren't in the group ahead of you.

Your thoughts race. If there are police to move highway traffic, why isn't there a course marshal to move traffic here? If we had a course ranger program, maybe we could play a round of golf in under six hours. I played Pleasant Fairways last weekend, and they had hard-working, friendly, knowledgeable people moving play along without any congestion or stress. Why can't our club have a successful marshal program?

What would it take to start one and what type of person would be able to do the job? Perhaps they could help the golf course, the course superintendent, and the golf pro.

All legitimate thoughts. So, what does a club look for in an individual who could be a successful course marshal? What personality traits are important, and what responsibilities would he or she have as part of the club staff? Developing a ranger program is often not as easy as it sounds. Perhaps a closer look is necessary, because properly trained people with the right personality and attitude can mean the difference between success and failure, whether your operation is public or private.

IF YOUR CLUB has paid employees on staff whose job it is to marshal the golf course, the job description can explain the club's policies, and the procedures and responsibilities of the marshal. However, many clubs, both public and private, may not have the finances for additional personnel. In this case, volunteer programs can be quite successful.

An incentive to boost volunteer involvement would be to offer compli-

mentary food and beverages, golfing privileges, or discounts on golf shop merchandise. Experience has shown that certain types of people are particularly well suited for this work, so concentrate your recruiting efforts on them.

The retired senior golfer who is willing to donate some time to the course is a good choice. Here is someone who has played golf his entire life, and enjoys sharing his experiences and his respect and love for the game with others. This affection for the game can rub off onto junior golfers, and can add to the club's activities, as well as encourage yet another person to play the game for life.

The young golf enthusiast who is the first one at the course in the morning and the last to leave at night is another prospect. He is always looking to fill in when one of the scheduled group doesn't make his starting time. He is often found asking the superintendent, golf pro, and general manager about course operations or career opportunities, in addition to helping each one if the need arises.

The individual who has a knowledge of the golf course layout is an asset for multi-course operations. Someone with solid working knowledge of the rules and the game, and who is friendly to the people who play regularly is required. This is especially true at daily-fee courses, where success or failure depends on drawing repeat customers.

In summary, course rangers should be friendly, courteous, patient, and firm in times of stress. They should be quality mediators for on-course decisions concerning slow play, rules disputes, and disorderly conduct, and should not be afraid to get their hands dirty on occasion.

ONCE A STAFF of rangers is established, a training period can begin that should include what their responsibilities will be to the golf course superintendent and golf professional. Since play can be intense at one time and slow at other moments, the ranger should be trained to handle both situations. There is more to the job than just moving people through the course at an even pace of play; a good ranger can serve some important needs of both the golf professional and the superintendent. At clubs where the ranger is paid, these duties can further justify his position.

For the golf professional, the ranger can help provide quality service and promote the course. He can be seen as an extension of the golf shop in many ways. Though the professional will have policies on course operation dealing with what is right and wrong, safe and hazardous, he cannot always be out on the golf course to enforce them. A properly trained marshal, then, can be an on-course extension of the professional and his operating procedures.

Maintaining pace of play is what most people see as the main function of the ranger. Golfers at their home club or at a resort, come to enjoy golf and get away from confusion and backups. As members or guests, they reserve a starting time and expect to play at the time they requested. If the ranger and starter are not moving people off the first tee and around the course, there will be a log jam of impatient guests in the golf shop berating the whole operation and demanding their money back. For those who are on the course playing a comfortable round in under 5½ hours, it means no waiting, and time to enjoy their game, as well as other activities of their stay. Good service means return customers.

DURING the busy season, an extra hand is always welcome around the clubhouse. Helping guests find their carts, showing them where the first or tenth tee is located, and even loading the players' bags onto the cart reflects the concern of the golf professional that the guests be treated to quality service.

Being an on-course representative, the ranger can help promote and advise players of what is available in the golf shop concerning merchandise and equipment. Some serve as a roving food and beverage service, with a cooler of cold drinks and small snacks. Carrying a small first-aid kit can help with minor bumps and bruises.

When schedules are established and the routine becomes familiar, the course ranger will see the entire course during his travels. With proper training from the golf course superintendent, he can follow through with many light and easy tasks to help maintain quality playing conditions.

Though not a trained professional, the roving ranger can be a valuable extra set of eyes for the superintendent. The ranger who is at the course early in the morning and well into the evening can take note of and report any unusual property or turf damage, such as broken tree limbs, fences, gates left open, or irrigation leaks. At times the late shift ranger may see a vandal driving a car across a green or tee. Though they cannot do anything to stop the damage, they may get a good look at the car and the license number of the vehicle.

The ranger can check each green and fix ball marks. His cart should have a small bucket of soil/seed divot mix available to fix many of the unrepaired divots. Also, he should carry a bunker rake to smooth out the footprints of careless players so the next group will have fair conditions. By fixing and repairing some of the everyday damage, the ranger sets an example of care for the course, which when witnessed by the golfers will carry over to them.

If your par-3 tees are small and the course receives heavy play, the ranger can move the markers either five yards ahead or behind the existing point to help preserve the turf. If time permits, he might take a quick check of the practice range to be sure the markers or bag racks are in place, and bring the empty ball buckets back to the shop.

On those long rides around and through the course, the ranger should be on the lookout for fallen or missing out-of-bounds and hazard stakes, and take appropriate action to have them replaced. At many courses rope is used as a barrier and a direction marker. During the course of the day much of this rope either falls down or is run over by carts. Carrying a small hammer for repairs, a ranger can keep ropes and stakes in place to prevent further wear and tear on the turf.

When there are on-course restroom facilities, the occasional backup or breakdown of the equipment can cause much aggravation to the emergency victim. In addition, the shortage or absence of needed supplies can be a cause of great concern among the guests. By keeping a constant watch for these mishaps, fewer people will suffer. Good service means return customers.

For many golf courses, a well-trained staff of polite, thoughtful, hard-working marshals could mean the difference between success and failure. Having rangers whose responsibility it is to insure a pleasant and safe round of golf is a valuable asset to any club. It helps make the game an even greater pleasure for everyone involved.

(Opposite page) Filling fairway divots, the ranger trained by the superintendent can ease the burden of daily maintenance and set an example of golf course etiquette for the players.

(Above) On the lookout for forgetful golfers, the ranger can provide fair playing conditions.

Mole Cricket Management vs. Control

by TOM BURTON
Superintendent, Sea Island Golf Club, Georgia

Two species of mole crickets, left to right: adult male tawny, adult female tawny, adult male southern, adult female southern.

THE MOST SERIOUS insect pests of turf in the southeastern United States are mole crickets. The tawny mole cricket (*Scapteriscus vicinus*) and the southern mole cricket (*S. acletus*) were inadvertently introduced into the United States from South America. The tawny mole cricket was first recorded at Brunswick, Georgia, in 1899. It seems likely that they traveled in ships' ballast that was dumped in preparation for taking on heavy loads of timber. The southern mole cricket was likewise introduced at the Brunswick, Georgia, port in 1904.

Turf damage caused by mole crickets results from direct feeding on roots and desiccation of roots through cricket tunneling in the soil. Where mole cricket populations are heavy, large areas of turf will die out. In areas where cricket populations are low, turf withstands the damage, but the raised areas of soil are unsightly and interfere with golf play. These creatures create another problem by tunneling through soil and breaking the barrier of preemergent herbicides, consequently contributing to our weed problems.

When the less-expensive long-residual insecticides were removed from the market several years ago, the crickets became more difficult and costly to control. Treatments were then made after damage had occurred, and although vast numbers of crickets might have been killed, we only scratched the surface. We

were throwing dollars at the problem, as much as $1,000 per hole, but we were not getting the job done.

When tournaments were held, we had a local rule (the Mole Cricket Rule), which allowed the player to play the ball as ground under repair if it landed in a mole cricket tunnel or mound.

It was evident we needed a comprehensive program of mole cricket management. Bill Jones, III, vice-president and part owner of the Sea Island Company, which owns and operates The Cloister Hotel, helped organize a cooperative effort between Sea Island Golf Club, Jekyll Island State Park Authority, and Sea Palms Golf & Tennis Resort. These three resort operations have a total of 144 holes of golf.

We looked for an entomologist with mole cricket experience, an understanding of our problem, and a recognition of the need for a different approach. We hired Dr. Leon Stacey, an agricultural consultant who was actively involved in mole cricket research while employed by the University of Georgia Cooperative Extension Service (1977-84). A brief summary of the cricket management program developed and used in 1987 and 1988 follows.

First instar nymph of tawny mole cricket. Peak hatching date is usually last of May through first two weeks of June.

DURING 1987, management strategies for mole crickets were tailored to meet the needs of each cooperating golf course. Large populations of crickets were the problem. To design control systems for such large populations, biological studies were conducted on crickets collected from pitfall traps.

Size, sex, and species determinations were made one time a week, and pregnant females were dissected to provide useful information on egg-laying activities and to predict peak egg hatch. Emphasis was placed on timing application of control materials to coincide with nymphal hatch.

Peak egg hatch occurred the week of June 12, in 1987, and the large population of hatching nymphs (½ million per acre) was reduced considerably.

Although peak hatchout of nymphs was accurately predicted and control materials were applied during peak hatchout, a high population of overwintered adults provided a consistent, continuous hatchout of nymphs during June, July, and August. Spot treatments were utilized on several holes while blanket treatments of insecticides were needed on others. Detailed mapping of crickets was used to determine which holes required spot treatments, etc. Candidate insecticides were screened to determine the most effective treatments, and we presently use only the most effective products available.

One of the most significant improvements in control of crickets through the use of sprays was the discovery of high alkaline content in the water from deep wells on St. Simons Island. The water pH ranges from 7.9 to 9.1; changes of 0.5 pH unit during one week are not uncommon. To improve insecticide performance in alkaline spray water, buffer material (Buffer-X, Buffer PS, Super Buff) is added to reduce water pH to approximately 6.5 before the pesticides are added.

Detailed cricket mapping during March and April was accomplished. Its purpose was to locate overwintered adults and carry out massive suppression before they laid their eggs. Spot treatments with residual insecticides (Mocap) were done on areas where adults were not controlled before April 15, and follow-up spot treatments were made with the short residual materials Sevin and Orthene, as dictated by cricket mapping.

These approaches provided excellent reduction in cricket numbers and damage. During May, June, and July, very few crickets could be found (less than 10 per hole). August and September rains generally favor outbreaks of crickets. These rains appear to bring all crickets to the surface, some of which apparently feed at depths that do not cause surface damage.

The major factors leading to the success of the 1988 program are:

1) Accurate monitoring of crickets (cricket mapping)
2) Buffering the spray water
3) Massive suppression of overwintered adults
4) Timing insecticide treatments to coincide with peak egg hatch

MAJOR ACCOMPLISHMENTS of the program to date have been a considerable reduction in insecticide costs, a tremendous improvement in turf quality, and improved weed control. As cricket numbers have been reduced, preemergence weed control has improved. Crickets are not present to break the preemergence barrier and allow weed seed germination.

In summary, we feel the new approach of total management is far superior to the old control method of killing mole crickets when we saw damage. Eradication of mole crickets as a pest on golf courses is not the goal of our program. We do feel, however, that by using sound management practices, turf damage and control costs can be reduced.

Through timing studies and frequent detailed mapping of cricket activity, we are getting maximum return for dollars spent, and mole cricket damage to turf is at a minimum. Good turf has eliminated the need for the local Mole Cricket Rule.

The present program has been partially funded to date by agricultural industries. We hope for additional funding from other sources in 1989.

LOW-WATER-USE TURFGRASSES

by DR. JAMES B. BEARD and DR. KI S. KIM
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WATER USE RATE is the total amount of water required for turfgrass growth plus the quantity transpired from the grass plant and evaporated from associated soil surfaces. It is typically measured as evapotranspiration, and expressed as ET in millimeters per day.

The comparative water use rates of turfgrass species are distinctly different from the relative drought resistances, because each is a distinctly different physiological phenomenon. For example, tall fescue is one of the more drought-resistant cool-season turfgrasses, but it possesses a very high water use rate. Reducing the turfgrass water use rate is a strategy associated with irrigated grasses. The goal is to select turfgrasses that require the least possible supplemental irrigation.

TABLE 1.
Relative ranking of evapotranspiration rates for the most commonly used cultivars of the major cool- and warm-season turfgrasses.*
Texas Agricultural Experiment Station, College Station, Texas

Relative Ranking	ET Rate (mm/day)	Turfgrass	
		Cool-season	Warm-season
Very low	< 6		Buffalograss
Low	6 -7		Bermudagrass hybrids Centipedegrass Bermudagrass Zoysiagrass Blue Grama
Medium	7 - 8.5	Hard fescue Chewings fescue Red fescue	Bahiagrass Seashore paspalum St. Augustinegrass Zoysiagrass, Emerald
High	8.5 - 10	Perennial ryegrass	
Very high	> 10	Tall fescue Creeping bentgrass Annual bluegrass Kentucky bluegrass Italian ryegrass	

*Grown in their respective climatic regions of adaptation and optimum culture regime. Cultural or environmental factors that cause a drastic change in leaf area or shoot density of a given species may result in a significant shift in its relative ranking compared to the other species.

Research at Texas A&M University conducted under a United States Golf Association grant has delineated the comparative water use rates among 19 turfgrass species used throughout North America (Table 1). The differences are substantial. Extensive research has been done with the warm-season turfgrasses — those species adapted to soil temperatures in the 80° to 95° F range, and commonly grown in the southern part of the United States. As a group, the warm-season turfgrasses have a lower evapotranspiration (ET) rate than the cool-season species. These evapotranspiration comparisons represent the rates that occur under non-limiting soil moisture conditions. The range in ET rates for the warm-season turfgrasses is 5.5 to 8.5 mm per day. The high-density, low-growing turfgrasses, such as buffalograss, centipedegrass, and hybrid bermudagrass, exhibited low water use rates. Other warm-season species, such as St. Augustinegrass, seashore paspalum, and bahiagrass, have exhibited medium water use rates.

Among the cool-season species, which grow best at soil temperatures in the 60° to 75° F range, comparative information is more limited. However, recently completed investigations at Texas A&M University have shown that the fine-leafed fescues rank medium in water use rate, while Kentucky bluegrass, annual bluegrass, and creeping bentgrass have exhibited very high water use rates when grown under non-limiting moisture conditions. These cool-season grasses have evapotranspiration rates ranging from 7.5 to 12 mm per day under high evaporative demand.

Mechanistic studies at Texas A&M University have revealed that certain specific types of plant morphology affect the resistance to evapotranspiration, and the surface area from which it occurs. The major factors are a low leaf area and a high canopy resistance, whose components are as follows:

High Canopy Resistance to ET	Low Leaf Blade Area for ET
High shoot density	Slow vertical leaf extension rate
High leaf number	
More horizontal leaf orientation	Narrow leaf

The professional turf manager should be aware of these particular plant characteristics that contribute to a low water use rate. These characteristics can be used as guidelines in selecting cultivars possessing a low water use rate. Furthermore, these same morphological traits can be used by turfgrass breeders to conduct rapid field selections of plants that are most likely to possess a low water use rate.

REFERENCES

1. Kim, K. S. 1983. Comparative evapotranspiration rates of 13 turfgrasses grown under both non-limiting soil moisture and progressive water stress conditions. M.S. Thesis. Texas A&M Univ., College Station, TX. p. 64.
2. Sifers, S. I., J. B. Beard, and K. S. Kim. 1986. Criteria for visual prediction of low water use rates of bermudagrass cultivars. Texas Turfgrass Research — 1986. pp. 22-23.

Drs. Ki S. Kim and James B. Beard on their stress plots at Texas A&M University, College Station, Texas.

TURF TWISTERS

TO FACILITATE HEALING

Question: An extensive tree trimming program is scheduled for my course this winter. What can I do to minimize the healing time? (Connecticut)

Answer: In the United States, dormant pruning is considered best, but it should be delayed until after the probability of extremely low temperatures. When you remove a large limb or a major branch, do not leave a long stub or cut the limb off flush with the trunk. Sever the branch or limb just past the natural swelling or collar that is usually at the point of branching. This will produce a smaller wound, and by leaving the collar intact, facilitate healing. Natural disease inhibitors seem to be in this area that will help prevent disease or infection at the wound site.

AND TO IMPROVE A RELATIONSHIP;

Question: I am the new green committee chairman at my club, but I am not familiar with the responsibilities of my new job. Do you have any information that may be of help? (Arkansas)

Answer: We surely do, and we urge you to write to your regional Green Section office (addresses found on the title page, inside front cover) requesting "The USGA Green Section Guide." The guide will introduce you to your new duties, and present new ideas for developing a great golf course and a great working relationship with your golf course superintendent.

READ CAREFULLY. FOLLOW DIRECTIONS!

Question: I've heard the USGA Specifications for Putting Green Construction call for a mixture of 80 percent sand and 20 percent peat. Is this correct? (Virginia)

Answer: It is amazing how the Green Section Specifications are so misunderstood. There are *NO* recommended set percentages of sand, soil, or peat. The Specifications are based on differing ranges of bulk density, porosity, moisture retention and the principles of a perched water table. They are designed to accommodate most locally available sands, soils, and organic materials, but they must first undergo a physical soil analysis by an experienced laboratory to determine the proper critical ratios of the available materials to be used.

You will be interested to know a new revised publication of the USGA Green Section Specifications will soon be available from all Green Section regional offices. Except for a few minor, subtle changes, they remain exactly as originally published in 1960. The new publication offers greater detail of the steps involved and warns there is no such thing as a "modified USGA green."